

Attachment 1

Specifications/Summary of Work

DTFAEN-12-R-00105

**ASR HVAC Unit Replacement at the Hartsfield-Jackson
International Airport**

Atlanta, GA.



**DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION**

**NEW ENGLAND REGIONAL OFFICE
12 NEW ENGLAND EXECUTIVE PARK
BURLINGTON, MA 01803**

**REPLACEMENT OF THE HVAC SYSTEM
AT THE AIRPORT SURVEILLANCE
RADAR BUILDING (ASR-9)
FOR
Hartsfield Int. Airport
Atlanta GA.
July 2012**



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SPECIFICATIONS
For
HVAC SYSTEM AT THE ASR-9 RADAR SITE
Hartsfield Int. Airport

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DIVISION 1 - GENERAL REQUIREMENTS

SECTION 1-1 SUMMARY OF WORK

1-1.1 **GENERAL**: These specifications and drawings, together with referenced specifications, standards and drawings specified in the contract documents, cover the requirements of the Federal Aviation Administration, hereinafter referred to as the Government or FAA, for all work associated with this project.

The location of the work is at the ASR-9 Radar, Atlanta GA

The Contractor shall furnish all labor, materials, and equipment in strict accordance with these specifications and drawings.

Construction work will require licensed tradesmen in accordance with local authorities having jurisdiction.

1-1.2 **SCOPE OF WORK**: The work to be performed consists of furnishing all labor, tools, handling, cutting and patching, equipment, and materials required to perform the entire scope of work, and without limiting the generalities thereof, includes the following:

These specifications together with the referenced specifications, cover the requirements of the Federal Aviation Administration for work associated with the demolition of the two existing A/C units and associated duct work and the installation of two (2) 30-ton Liebert Air Handling Units along with associated external condensing sections, floor stands, and all associated duct work at the ARSR-9 building at Atlanta GA. The contractor shall perform the following:

- 1) Remove and dispose of the three existing A/C units, inside ductwork, and outside electrical system feeding the two 25 ton systems.
- 2) Install two new 30 ton Deluxe System Liebert DX up flow A/C units with their matching condenser sections with Lee-Low temp heated receivers and 4 foot extension legs, new supply duct system, new electrical power wiring to include new electrical breakers and new A/C controls. The contractor shall drill (using a professional concrete cutting company) all holes for piping and electrical power to two new external condensing units. Contractor shall provide all rigging of equipment (installation and removal) as required using a professional rigger.
- 3) The contractor shall patch all openings in the building pertaining to the old HVAC system. Include the removal of the relief louver.
- 4) The contractor shall install a new duct system for both units as shown on the plans. Include new supply air diffusers. (To be field determined for exact number and location)
- 5) Relocate any and all electrical panels and electrical conduits in the immediate vicinity of the new A/C units.
- 6) Provide a new power feed for each air handler and condenser. (New main breakers, stainless steel disconnect switches, electrical wiring, new aux. power panel for the condensers and heated receivers etc.
- 7) All electrical work shall be performed in accordance with FAA 1217F

- 8) Install new grounding to the outside condensers per FAA 0019E. Cad weld to counterpoise.
- 9) Provide floor stands with stainless steel drain pans for each air handler. Include all drain plumbing.
- 10) Re-locate any ceiling lighting fixtures as needed to accommodate the new HVAC system.
- 11) Cut a new door frame and duct opening into the wall leading to the new office space and supply a new steel door and lock mechanism.
- 12) Relocate the two outside condenser units feeding the UPS room to accommodate the new Liebert Condensers.

1-1.2.1 Division of Specifications - These specifications is divided for convenience into sections as set forth in the Table of Contents. The items of work listed under each section are given for convenience and shall not be construed as a comprehensive list of items necessary to complete the work of any section.

1-1.2.2 LIST OF DRAWINGS: The following drawings, together with these specifications, define the work to be completed under this contract:

To be added

1-1.2.3 Standard references.- Military, Federal, Society Institutes and Associations, standards, specifications and codes, of the issues in effect on the date of the Invitation for Bids, form a part of this specification and are applicable to the extent specified in each specification section.

1-1.2.4 Drawings.- As listed in paragraph 1-1.12, these drawings for the Architectural, Structural, Mechanical, Electrical installation and site work form a part of the construction requirements for this project.

1-1.3 Safety and health regulations.- The contractor shall comply with the occupational safety and health requirements as detailed in Order 4402.1B. See Section 1-14.

1-1.4 Contracting officer.- The term "Contracting Officer" (CO) as used denotes the person designated to act on behalf of the Federal Aviation Administration (FAA) in the performance of the contract.

1-1.5 Contracting officer's technical representative.- The term "Contracting Officer's Technical Representative" (COTR) as used denotes the authorized representative of the contracting officer for onsite coordination. The COTR shall be the focal point for all coordination between contractor and the airport authorities. The COTR represents the Government primarily in technical matters related to the plans and specifications of the project.

1-1.6 Safety.- The contractor shall comply with all safety requirements of the airport operator. See Section 1-14.

1-1.4 EXISTING FACILITY OPERATIONS: All construction work shall be performed so that normal facility operations may continue with minimal disruptions. This facility must continue to operate 24 hours a day, 7 days a week. All necessary outages must be scheduled with one week's notice given to the COTR. Work shall be staged to maintain temperature control at the facility. The existing units shall be used to maintain adequate cooling and heating during construction. Access to the facility shall be kept unobstructed at all times. The contractor shall coordinate his activities with those of other contractors working in the area to avoid delays and interference.

1-1.5 TIME OF PERFORMANCE: The work shall be completed within 180 days after the Contracting Officer provides a notice to proceed.

1-1.6 PRECONSTRUCTION CONFERENCE: As soon as practicable after the contract has been awarded, and submittals have been approved, a preconstruction conference between representatives of the FAA, and the Contractor will be scheduled.

1-1.7 SPECIFICATIONS AND DRAWINGS: Five (5) sets of full size drawings and specifications will be furnished to the successful offerer. Additional sets will be furnished upon request at the cost of reproduction and shipping.

1-1.8 REFERENCED SPECIFICATIONS: The Contractor shall be responsible to obtain all referenced specifications and FAA Standards listed within these specifications. If problems are experienced in obtaining FAA Standards, the Contractor shall notify the COTR.

1-1.7 Pre-bid conference.- A site visit may be arranged at the Atlanta GA ASR-9.

1-1.8 Preconstruction conference.- The contractor shall attend a preconstruction conference to be conducted by the FAA with the facility management. Local procedures related to ingress-egress, use of premises, security, construction work schedule, temporary facilities and material disposal will be discussed. The time and location for the preconstruction conference shall be established by the Contracting Officer after contract award.

1-1.9 As-built drawings.-Contractor shall provide COTR with three (3) sets of final as-built drawings pertaining to the construction of the job. Drawings shall be provided within 60 days of substantial completion of the project.

The As-Builts shall be provided on a CD formatted for Microstation.

1-1.10 Utility connections.-It shall be the contractor's responsibility to contact each individual utility company when needed. Phone numbers and points of contact can be obtained from the COTR on site.

1-1.11 Temporary Power - Contractor will be allowed to access the facility power for his equipment. Any electrical outlets for the use by the contractor shall be approved by an FAA official.

SECTION 1-2 CUTTING, PATCHING AND CLEANING-

1-2.1 Building Openings: The contractor will be responsible for the block closure of openings from the removal of the old duct system any associated penetrations including the outside damper located near the power panel wall.

1-2.2 Facility Restoration: The contractor shall provide any and all material and labor to restore the building and grounds to match the existing untouched facility.

Required patching:

All outside duct work building penetrations

Exhaust louver penetration

Roof exhaust penetration

Concrete pad removal added stone

Exterior/Interior Wall painting

Any and all door removal and re-installation associated with the Installation of any equipment used in the completion of this project.

SECTION 1-3 SUBMITTALS

1-3.1 GENERAL: This section covers the procedure and requirements of all submittals. Detailed submittal requirements are specified in each section of these specifications.

1-3.2 APPLICABLE DOCUMENTS: Submittals are required for EVERY NEW PIECE OF EQUIPMENT AND FOR ALL CONSTRUCTION MATERIALS.

1-3.3 REQUIREMENTS:

1-3.3.1 Definition: Where the word "Submittal" is used it refers to the submitting of shop drawings, specifications, samples, manufacturer's catalog cuts, technical data, installation instructions, material/equipment lists, test reports, certificates, guaranties, operation and maintenance manuals, warranty books, and as-built drawings.

1-3.3.2 Approval: Samples, certificates, test reports, and shop drawings shall be submitted in advance for a determination of specification compliance by the Government (FAA) before materials are delivered at the site. The time necessary for approval or disapproval of samples, certificates, test reports, and shop drawings is at least seven (7) calendar days after receipt of the items. All materials installed in the work shall match the approved submittal. After a submission by the Contractor has been approved, no substitution will be permitted without written approval by the COTR or his/her authorized representative. Any disapproved submittal must be resubmitted within five (5) calendar days. Unless otherwise specified, number of copies of submittals shall be as follows:

Samples: As specified in each section.
Certificates, Test Reports, Warranties, etc.: 5 copies
Shop Drawings, Manufacturer's Brochures: 5 copies
Material Lists & Installation Instructions: 5 copies
Maintenance Manuals: 5 copies
As Built Drawings: 3 copies on CD

1-3.3.3 Samples, Certificates, and Test Reports: Unless otherwise directed by the COTR, the Contractor shall submit samples in sufficient size and quantity as required to perform the test or evaluation called for. Samples shall be accompanied by the manufacturer's certificate of compliance or certified test reports, in triplicate. Properly label each name and brand, name of project, Contractor's name and date of submission. Samples for selection of color, texture, and finish shall show the extremes in range, if any, of the colors, textures, and finishes of the items to be furnished. The Contractor shall bear all costs associated with samples, tests, certificates, reports, and shop drawings required by this specification or noted on the contract drawings, except FAA testing.

1-3.3.4 Shop Drawings: The term "Shop Drawings" includes drawings, diagrams, layouts, schematics, descriptive literature, illustrations, schedules, performance and test data, and similar materials furnished by the Contractor to explain in detail specific portions of the work required by the contract.

- a. The Contractor shall coordinate all such drawings and review them for accuracy, completeness, and compliance with contract requirements and shall indicate his approval thereon as evidence of such coordination and review. Shop drawings submitted to the COTR without evidence of the Contractor's approval may be returned for resubmission. The COTR will indicate his approval or disapproval of the shop drawings and if not approved as submitted shall indicate his reason therefore. Any work done prior to such approval shall be at the Contractor's risk. Approval by the COTR shall not relieve the Contractor from responsibility for any error or omissions in such drawings, nor from responsibility for complying with the requirements of this contract, except with respect to variations described and approved in accordance with paragraph b. below.

- b. If shop drawings show variations from the contract requirements, the Contractor shall describe such variations in writing separate from the drawings, at the time of submissions. If the Contracts Administrator approves such variations, he shall issue an appropriate contract modification, except that, if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued.
- c. The Contractor shall submit to the COTR for approval five copies (unless otherwise indicated herein) of all shop drawings as called for under various headings of these specifications. Four sets of all shop drawings will be retained by the COTR and one set will be returned to the Contractor.

1-3.3.5 **As-Built Drawings:** The Contractor shall maintain, correct and protect at least two sets of contract drawings and specifications during this contract. These drawings shall include all changes whether initiated by contract modification, changed conditions, mutual consent, shop drawings or submittal data, "as-built" conditions, etc. One set of these drawings shall be used for layout during construction progress by all trades. Within 5 calendar days after installation and/or construction work is complete, these two sets of drawings and specifications shall be submitted to the COTR as "as-built" drawings. A FINAL SET OF AS-BUILT drawings shall be provided to the FAA at the completion of the project. These drawings shall be formatted to be included as compatible with MICRO-Station CAD software. A hard copy (NOT RED LINES) of the final construction are to on the CD.

1-3.4 SUBMITTALS: The following list of submittals shall be transmitted in writing, with the number of copies as previously specified, to the Contracting Officer, FAA, Eastern Acquisitions-Southern Region AAQ-510, 1701 Columbia Avenue, College Park, GA. 30337, three (3) weeks prior to the scheduled installation unless otherwise noted below. A Construction Schedule shall be received at same location within seven (7) days after the Notice of Award. Notice to proceed shall be withheld until these submittals have been received and approved.

- 1. Construction Schedule.
- 2. As-Built Drawings; prior to final inspection.
- 3. Warranty Books.
- 4. HVAC Units.
- 5. Controls.
- 6. Detailed Safety Plan
- 7. Electrical system upgrade

SECTION 1-4 SITE ACCESS, COORDINATION, AND WORK HOURS

1-4.1 GENERAL: This section covers the requirements of site access, construction limits, Contractor's use of premises, on-site working hours, coordination between Contracting Officer's Technical Representative (COTR), FAA, and the Contractor.

1-4.2 APPLICABLE DOCUMENTS. Not applicable.

1-4.3 REQUIREMENTS:

1-4.3.1 Access to the Site: Access to the job site shall be as indicated on the drawings or as directed by the COTR.

1-4.3.2 Construction Limits and Access: The Contractor shall confine operations, activities, storage of materials and employee parking within a designated area. Additional space, when the Contractor deems necessary, shall be obtained off-site at no additional cost to the Government.

1-4.3.2.1 The Contractor shall comply with all FAA instructions, rules, regulations, or other directives of the authorities having jurisdiction over the premises. The Contractor shall prevent any abuses, damage, spillage, etc. to such areas used, and shall maintain and restore them to their original condition at the conclusion of the work.

1-4.3.2.2 Materials and Equipment Storage: Materials and equipment within or outside the building shall be neatly stacked. If stored within the building, materials shall be so placed that they will not load any part of the structure in excess of the loads for which it was designed, nor interfere with the safe execution of the work. Storage of petroleum products or any other flammable materials in the premises is prohibited.

1-4.3.2.3 Waste Area: The contractor shall be responsible for the removal of all waste generated as a result of this construction project. At no time will the contractor be allowed to use the waste facilities of the FAA. No waste shall be dumped at the project site or within the premises.

1-4.3.3 Inspection of the Site by the Contractor: The Contractor shall carefully examine the premises to determine the extent of work and the conditions under which it must be done.

1-4.3.4 Contractor's Use of the Premises: The Contractor shall have complete and exclusive use of the premises within the construction staging area limits for the execution of the work. The Contractor shall assume full responsibility for the protection and safe keeping of products stored on the site. The Contractor shall maintain the job site in a neat and orderly condition. This includes the daily removal of rubbish, waste, and tools, equipment and materials not required for the work in progress as specified.

1-4.3.5 Government Use and Access to Premises: The Government reserves the right to enter the Contractor's job site during the term of the contract for periodic work inspection.

1-4.3.6 Working Hours: Work that is to be performed shall be performed between the hours of 7:00 AM and 3:30 PM or as prescribed by the COTR. All work shall be coordinated with the COTR, Particularly the work that will take place in the ASR-9 Room. This facility is operational 24 hours a day. All efforts shall be made to minimize the impact on Air Traffic operations. No work shall be scheduled on holidays or other hours without prior approval of COTR. The contractor may be required to perform some work at off peak hours or may not be allowed to work on site during extenuating circumstances. The FAA shall not be responsible for loss of time to the contractor for these aforementioned circumstances.

1-4.3.6.1 Overtime Work: In the event the Contractor intends to work overtime, he shall obtain an approval from the COTR at least 24 hours in advance of his commencing overtime work. Approval by the COTR for overtime work shall not be construed as an agreement for payment of overtime work. No interruption to site operations will be tolerated. In the event any of the facility services or utilities is interrupted, the Contractor shall restore services with full crew on a 24 hour basis including COTR approved working during holidays and weekends.

1-4.3.7 Coordination: All work shall be coordinated with the COTR or his authorized representative. The Contractor shall maintain continuous communication with the COTR while working on the job site. The Contractor shall utilize competent, licensed operators and installers and provide and maintain his equipment in acceptable working order.

1-4.3.7.1 The Contractor shall be required to arrange his work schedule when working near active facilities so as not to interfere with normal operations. Any operation of the Contractor which would interfere with or endanger the operations of the premises shall be performed only at a time and in a manner directed by the COTR.

1-4.4 SITE SECURITY: This facility must remain secured at all times. The Contractor must insure the access gate is closed after entry onto the site, while the Contractor is on site and after he departs the site. The COTR shall be the final judge of acceptable site security. **This site is co-located within the Hartsfield Int. Airport. The contractor shall be provided escorted access by an FAA person at all times.**

SECTION 1-5 TEMPORARY FACILITIES

1-5.1 GENERAL: This section describes the requirements for the Contractor's temporary construction facilities and utilities at the job site, required during the period of this contract.

1-5.2 APPLICABLE DOCUMENTS: The following publications of the issues in effect on the date of this solicitation form a part of this section.

- a. Department of Industrial Relations - General Industrial Safety orders.
- b. Federal OSHA - Construction Safety Orders.

1-5.3 MATERIALS: Not applicable.

1-5.4 CONSTRUCTION:

1-5.4.1 Contractor's Field Office: At the Contractor's expense, prior to starting work, temporary facilities for the Contractor's site office space, proper storage of materials and tools, and equipment employed in the performance of the work shall be provided and maintained for the duration of the Contractor's operations at the location as directed by the Site Construction Engineer.

1-5.4.2 Toilet Facilities: For the duration of the work, toilet facilities will be provided at the site by the FAA.

1-5.4.3 Removal of Temporary Facilities: At completion of the work, the Contractor shall remove all temporary facilities from the site and the portion of the site occupied by the temporary facilities shall be properly cleaned and graded and left in an acceptable condition to the COTR.

1-5.4.4 Telephone: The Contractor shall provide the COTR with a point of contact for emergencies after normal working hours.

1-5.4.4.1 Use of Government on site Telephone: The Contractor must provide and pay for his own telephone service at the job site. This may either be a temporary line or cellular phone. The Contractor may not use facility phones or the COTR's phone.

1-5.4.5 Heat, A/C and Essential Services: Provide and maintain heat, Air conditioning, electrical and any other critical services to protect the Facility against injury from dampness, wind, cold and rain until final acceptance of all work of the Contract. The contractor shall provide a temporary 35 ton AC unit to maintain the cooling inside the building at all times. The system shall be installed prior to construction. No construction shall commence until proof of cooling is demonstrated.

Temperature shall be maintained at 70deg F.

1-5.4.6 Temporary Utilities: Send proper notices, make all necessary arrangements, and perform all other services in the care and maintenance of all public utilities.

1-5.4.6.1 Water for Construction and Personal Use: Water will be provided at the site by the FAA.

1-5.4.7 Guards and Lights: Install and maintain from the beginning to the completion of the work all construction canopies, guards, railings, lights, obstruction lights, and warning signs necessary and required by law, and take all necessary precautions required by City, County, State, or other law and as required to avoid injury or damage to any and all persons and property. Protect all service mains, pipes, lamp posts, and fire hydrants or other public or private

utilities. Particular care shall be exercised to protect all adjoining surfaces, equipment, utility lines, materials, and structures from damage, including damage by fire or water, and by the Contractor's operations. All work shall be performed in a safe manner and in accordance with Federal Construction Safety Orders and General Industrial Safety Orders, Department of Industrial Relations. Any damage to the work or materials of others, or to other structures resulting from the Contractor's operations under this contract shall be promptly repaired or replaced at the expense of the Contractor and to the satisfaction of the COTR .

1-5.4.8 Temporary Construction Equipment: The Contractor shall furnish and maintain all equipment, such as temporary hoists, chutes, derricks, scaffolds, stairs, ramps, runways, ladders, and similar items required for the proper execution of the work. All such apparatus, equipment, and construction shall conform to all "safety requirements" under this contract. All temporary work and facilities shall be removed upon completion of construction or sooner, if so directed by the Site Construction Engineer.

1-5.4.9 Scaffolding: Not Used.

1-5.4.10 Sleeves and Equipment Bases: The Contractor shall coordinate the sizes, locations, and installations of all sleeves, curbs, pitch pockets, and equipment bases in a time and manner to avoid any hindrance to the work of other trades. In the event that sleeves, inserts, and any embedded items are not placed in time, the Contractor shall form required openings in the work and shall be held responsible for any subsequent related cutting and patching.

SECTION 1-6 TESTS, INSPECTIONS, AND PERMITS

1-6.1 GENERAL: This section sets forth the requirements for testing, inspections, permits and responsibilities for the completed work.

1-6.2 INSPECTIONS:

1-6.2.1 Access for Periodic Inspection: The Contracting Officer may from time to time designate certain persons other than site COTR to perform periodic inspections of the facility being constructed and/or upgraded under this contract. The Contractor shall allow such authorized persons complete access to all portions of the work, and shall make available all records related to occupational safety and health, which are required by law.

1-6.3 PERMITS AND RESPONSIBILITIES: The Contractor shall, without additional expense to the Government, be responsible for obtaining any necessary licenses and permits, and for complying with Federal, State and Municipal laws, codes, and regulations applicable to the performance of the work. The Contractor shall be also responsible for all damages to persons or property that occur as a result of the Contractor's fault or negligence, and shall take proper safety and health precautions to protect the work, the workers, the public, and the property of others. The Contractor shall also be responsible for all materials delivered and work performed until completion and acceptance the entire work. A copy of the license and permits obtained by the Contractor shall be submitted to the COTR.

SECTION 1-7 MATERIALS, EQUIPMENT, AND WORKMANSHIP

1-7.1 General: This section covers the general requirements of materials, equipment, and workmanship required for the performance of this contract. All materials and equipment required for the accomplishment of this project shall be furnished by the contractor. Detailed requirements are specified in each section of the specifications.

1-7.2 Materials: Materials and equipment shall comply with all requirements of the contract documents. Materials shall be furnished new and shall be standard products of manufacturers regularly engaged in the production of such materials and of the manufacturer's latest designs that comply with the specification requirements.

1-7.2.1 Ordering of Materials: The Contractor shall promptly, after the execution of this contract and approval of submittals, place orders for the materials and/or equipment so that delivery may be made without delays to the work. The Contractor shall be responsible for verifying all dimensions, styles, types, models, functions, etc. prior to placing the order of the materials/equipment, even when model numbers may be provided within the contract documents.

1-7.2.2 Container Shipped: Materials and/or equipment shall be delivered in their original unopened containers bearing the manufacturer's label.

1-7.2.2.1 Storage and Protection of Materials: Store all materials and containers that are subject to damage from moisture of the ground, under a waterproof cover. Store all material so as to prevent damage to the equipment until installed as shown.

1-7.3 Materials and Workmanship:

1-7.3.1 All equipment, material, and articles incorporated into the work covered by this contract shall be new and of the most suitable grade for the purpose intended, unless otherwise specially provided in this contract. References by trade name, make, or catalog number shall be regarded as establishing a standard of quality and shall not be construed as limiting competition. The Contractor may, at its option, use any equipment, material article, or process that, in the judgment of the COTR, is equal to that named in the drawings and specifications, unless otherwise specifically provided in this contract.

1-7.3.2 All work under this contract shall be performed in a skillful and workmanlike manner. All employees of the Contractor and his subs shall be licensed or verifiably qualified to complete the work assigned. The COTR may request, in writing, that the Contractor remove from the work site any employee deemed incompetent, careless, or otherwise objectionable.

1-7.4 Substitute Material and Options:

1-7.4.1 Approval: **In those instances where the contractor submits for approval material of higher quality than that specified, the approval of such material by the COTR shall not obligate the FAA to pay any additional costs which may be associated with furnishing and installing the substitute material.**

1-7.4.2 Submittal: **The Contractor, when submitting for approval material which is other than that cited in the contract, shall submit information necessary to allow for a thorough review by the COTR. This material shall include, but not necessarily be limited to: scale drawings, wiring and control diagrams, catalog cuts, and performance and test data.**

1-7.4.3 Quality: Where the use of optional materials or construction is permitted by the specification or drawings, the requirements for workmanship, fabrication, and installation specified or shown for the prime material shall apply

equally to the option. The Contractor shall make any change or adjustment in work necessary in the work resulting from the use of such optional material at no additional cost to the FAA.

1-7.5 Guarantee of Work: All materials/ equipment installed under this contract and all labor shall be guaranteed/ warranted for a period of not less than two (2) Years for the date of the final project acceptance. Equipment with a warranty period in excess of 5 years shall be guaranteed for the total warranty period. If, during the warranty period, the FAA detects a problem with the installed work, the Contractor shall promptly return, at no additional cost, and repair the work with new materials to the satisfaction of the COTR

SECTION 1-8 CONSTRUCTION CONTROL

1-8.1 SCOPE: This section describes the general construction control requirements. More specific and detailed requirements are specified in each section of these specifications.

1-8.2 APPLICABLE DOCUMENTS: Not applicable.

1-8.3 PROTECTION:

1-8.3.1 Protection of New and Existing Work: The Contractor shall be responsible for the security and protection of the work under construction and of the completed work until the Government has made final acceptance. Parts of the work in place that are subject to damage, because of Contractor's operations being carried on, adjacent thereto, shall be covered, boarded up or substantially enclosed with adequate protection.

1-8.4 PROTECTION OF EXISTING FACILITIES: The Contractor shall take all measures necessary, including erecting temporary partitions and shoring, as directed, to prevent damage to existing facilities. The Contractor shall protect from damage all existing improvements and utilities (1) at or near the work site and (2) on adjacent property of a third party, the locations of which are made known to or should be known by the Contractor. The Contractor shall repair any damage to those facilities, including those that are the property of a third party, resulting from failure to comply with the requirements of this contract or failure to exercise reasonable care in performing the work. If the Contractor fails or refuses to repair the damage promptly, the COTR may have the necessary work performed and charge the cost to the Contractor.

1-8.5 NONCOMPLIANCE BY CONTRACTOR: The COTR shall notify the Contractor of any noncompliance with the requirements of this contract and of the corrective action required. This notice, when delivered to the Contractor, shall be deemed sufficient notice of the noncompliance and corrective action required. After receiving the notice, the Contractor shall immediately take corrective action. If the Contractor fails or refuses to take corrective action promptly, the COTR may issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall not base any claim or request for equitable adjustment for additional time or money on any stop order issued under these circumstances.

SECTION 1-9 CONTRACT CLOSE-OUT

1-9.1 GENERAL: The Contractor shall be required to close out the contract in the manner described below.

1-9.2 APPLICABLE DOCUMENTS: Not applicable.

1-9.3 COMPLETION OF WORK:

1-9.3.1 Prior to submitting completion certificate, the Contractor shall place all apparatus furnished and installed under the contract into successful operation according to manufacturer's instructions, including lubrication and making of all required adjustments and testing and operation checks.

1-9.3.2 Completion Certification: When the Contractor considers the work is complete, he shall submit written certification that contract documents have been reviewed; work has been inspected for compliance with contract; equipment and systems are operational; operation and maintenance manuals, warranty books, as-built drawings, data and parts lists have been submitted and approved; spare parts have been provided as required; instructions to the maintenance personnel has been accomplished; and work is completed, premises cleaned and ready for final inspection.

1-9.3.3 Final Inspection: The COTR will schedule the final inspection Joint Acceptance Inspection (JAI) upon approval and endorsement of this Contractor's completion certificate. The final inspection may include a representative of the Airway Facilities Sector responsible for the facility.

1-9.3.4 List of Discrepancies (Punch List): The COTR will furnish the Contractor with a list of discrepancies in the work, material and equipment noted during the final inspection.

1-9.3.5 Acceptance of Work: The Contractor shall correct discrepancies noted during the final inspection, clean the premises and notify the COTR that the adjusted work is ready for re-inspection. After discrepancies are corrected, the final as-built drawings shall be submitted to the COTR.

SECTION 1-10 MANDATORY SAFETY REQUIREMENTS

1-10.1 GENERAL: The Contractor shall be required to provide a safe work area to protect the lives and health of workers, inspectors, and pedestrians from any hazards that may be present. The Contractor shall implement all measures for preventing damage to property, materials, supplies, and equipment and avoiding work interruptions. To accomplish this objective, the Contractor shall comply with all applicable OSHA, federal, state, and local safety regulations. The Contractor shall comply with the standards issued by the Secretary of Labor at 29 CFR Part 1926 and 29 CFR Part 1910. **The Contractor shall provide a detailed written safety plan to the Contracting Officer after Notice of Award for review and nominate a Contractor's site safety officer. Upon receipt, the safety plan shall be posted on the job site for all personnel to see. No construction shall commence until final FAA approval.**

1-10.2 SAFETY PLAN: The safety plan shall be according to the intent of the contract, and normal and accepted industry and FAA standards as follows:

- a. The name and position of the person responsible for implementing and enforcing the Safety Plan.
- b. Construction safety education and training given to workers prior to commencement of the work. Employer must explain the particular hazards and outline protective measures to prevent accidents. Follow-up sessions must be planned to reinforce the commitment to safety during the construction period.
- c. A system of rules and regulations for eliminating health and safety hazards as well as eliminating unsafe work practices.
- d. On-site safety inspections. Use a systematic approach with a written checklist that is kept on record.
- e. An accident investigation plan to effectively determine the causes and determine how to prevent future accidents.
- f. A listing of all hazardous chemicals and materials which will be used on the job shall be provided along with their respective MSDS's (Materials Safety Data Sheets). This information will also be posted on site.

1-10.3 MINIMUM REQUIREMENTS: The following actions shall be provided for on the construction site and included in the safety plan as conditions dictate:

- a. Posting phone numbers for ambulance, hospitals, police, and fire departments, along with a strip map to each, near a phone in a location accessible by all personnel.
- b. Using job-required personal protection including hard hats, protective footwear, eye protection, respiratory protection, work gloves, and hearing protection if needed.
- c. Providing and locating the proper class of fire extinguisher(s) and first aid kits in a conspicuous place.

- d. Presenting appropriate instructions and/or construction safety talks for the safe and proper use of portable electric tools, ladders, scaffolds, hazardous materials, earplugs, and other personal protective equipment.
- e. Practicing good common sense housekeeping practices as required to keep area safe and minimize unsafe hazardous situations and potential falling objects.
- f. Establishing safe torch-welding and CADWELD procedures. Use eye, skin, and hand protection, and clear area of other workers.
- g. Posting company's insurance certificate/notice to employees as required, and the name/phone number of the Contracting Officer.
- h. Assuring operational safety on airports and coordinating work with all airport authorities.

1-10.4 ACCIDENT/DAMAGE REPORTING: The Contractor shall maintain an accurate record of exposure data on all accidents incident to work performed under this contract resulting in death, traumatic injury, or damage to property, materials, supplies, or equipment. The Contractor shall report this data in the manner prescribed by the COTR.

1-10.5 CONTRACTOR SAFETY VIOLATIONS: The COTR shall notify the Contractor of any noncompliance with these requirements and of the corrective action required. Noncompliance provisions under section 1-8.5 of these specifications shall apply.

SECTION 1-11 MANDATORY PROJECT SCHEDULE

1-11.1 GENERAL: The Contractor shall be required to provide a complete and detailed construction schedule to Contracting Officer for approval prior to beginning any work. The Contractor shall prepare and submit to the COTR for approval three copies of a practicable schedule showing the order in which the Contractor proposes to perform the work, and the dates on which the Contractor contemplates starting and completing the several salient features of the work (including acquiring materials, plant, and equipment). This schedule will enable the COTR to monitor the work, process progress payments, and coordinate between the Contractor and the FAA. If the Contractor fails to submit a schedule within the time prescribed, the COTR may withhold approval of progress payments until the Contractor submits the required schedule. The schedule shall be updated and revised as required.

1-11.2 MINIMUM REQUIREMENTS: All significant activities, phases of construction and planning, as well as all contractor activities shall be included in the schedule. The plan shall include but not be limited to the following activities as applicable:

- a. Planning phase.
- b. Permits
- c. Procurement of materials, equipment, etc.
- d. Site preparation.
- e. Electric (Include all planned shut-downs and interruptions to facility power.)
- f. Inspections - Final, special.

1-11.3 FORMAT: This schedule will be presented in the form of a bar chart which as a minimum details the activity, duration, start, finish, float time, and preceding and following activities. Each activity or major activity group shall also be allocated with a portion (percent) of the total contract dollar value to assist in processing of progress payments.

SECTION 1-12 GOVERNMENT FURNISHED MATERIAL

1-12 GOVERNMENT FURNISHED MATERIAL: N/A

DIVISION 15 MECHANICAL

SECTION 15-5

DIVISION 15-5 HEATING, VENTILATION AND AIR CONDITIONING

These Specifications cover the demolition of the existing HVAC system including the removal of the existing duct system and outside A/C units, concrete pads, and electrical power. The contractor shall install the new A/C units inside the building which will require new pipe openings in the block wall, install new duct work, controls and power for the new units. The contractor shall also provide new diffusers as noted on the drawings. Upon completion of the modifications, the entire HVAC system must be rebalanced and required reports submitted.

15.5.1 Mechanical General Provisions

15-5.1.1 General This section includes furnishing all labor, apparatus and materials required for the complete mechanical installation as shown on the drawing and/or included in the specifications.

15-5.1.2 Scope Of Work

See section one "General Requirements" for the scope of work.:

15-5.1.3 After all modifications have been completed, the portions of the system altered shall be rebalanced to insure that the air flow is in agreement with the design requirements.

15-5.1.3 Code Requirements And Permits

Perform all work in accordance with applicable statute, ordinances, codes, in force during the time of construction period, and any regulations of governmental authorities having jurisdiction. Contractor shall obtain and pay for all permits and inspections.

15-5.1.4 Order Of Precedence

The Contractor shall lay out work well in advance. A construction plan shall be submitted by the contractor in advance of the start of work outlining the installation of the new system and removal of the old system. The old system shall remain on line until the new system is in working order. This site runs 24 hours per day, seven days a week and can not afford to be shut down during construction.

The contractor shall follow the following plan for the removal and installation of the HVAC system:

- 1. Install a temp 35 ton AC unit at the ASR.**
- 2. Remove both 25 ton AC units and associated duct work, and electrical system.**
- 3. Relocate the two condenser sections that feed the UPS room.**
- 4. Install a new electrical dist. System for both Liebert systems.**
- 5. Pipe all refrigeration lines.**
- 6. Provide all electrical connections from all the HVAC equipment to the main breaker panel.**
- 7. Replace old duct system with new duct system as shown on the plans. Connect system to new air handlers. Include isolation dampers for each unit with limit switches on dampers.**
- 8. Install new Liebert systems.**
- 9. Pipe all refrigeration lines.**

10. Connect interior duct system to both air handlers and start system.
11. Provide all new refrigerant for both Lieberts and properly charge system.
12. Provide Liebert startup.
13. Fine tune new system as needed.
14. Remove temp AC unit.
15. Restore facility
16. Provide Liebert training for new units.

15-5.1.5 Applicable Publications

The following documents of the organizations and official bodies named, of the issues in effect on the date of the Screening Information Request (SIR), form a part of this specification and are applicable to the extent specified herein.

15-5.1.6 Reference Specifications And Standards

Materials which are specified by reference to Federal Specification, ASTM, ASME, ANSI, SMACNA or AWWA Specifications, Federal Standards, or other standard specifications must comply with latest editions, revisions, amendments or supplements in effect on date bids are received. Requirements in reference specifications and standards are minimum for all equipment, material and work.

15-5.1.7 Materials And Equipment

Contractor shall furnish labor, materials, tools, equipment, and supervision to complete the project, to the existing HVAC system at the ASR-9

15-5.1.8 Installation

All equipment is to be installed according to the FAA drawings, manufacture's instruction, and in accordance with accepted practices.

15-5.2 Applicable Publications - The following documents of the organizations and official bodies named, of the issues in effect on the date of the SIR form a part of this specification and are applicable to the extent specified herein.

1-5.2.1 Federal Specifications

- | | | |
|----|----------|--|
| a. | HH-1-545 | Insulation, thermal and acoustical (mineral fiber, duct lining material) |
| b. | WW-T-799 | Tubing, copper, seamless |
| c. | QQ-S-698 | Steel, sheets, carbon, low carbon |
| d. | QQ-S-700 | Steel, sheet and strip, medium and high carbon |
| e. | QQ-S-775 | Steel, sheets, carbon, zinc-coated |

15-5.2.2 American Insurance Association - National Building Code.

15-5.2.3 Sheet Metal and Air Conditioning Contractors National Association, Inc.,

Low Velocity Duct Construction Standards.
HVAC Duct Construction STDS
Fibrous Glass Duct Construction STDS
HVAC Air Duct Leakage Test Manual
HVAC Testing, Adjusting and Balancing

15-5.2.4 Military Specifications

- a. MIL-C-7 Cloth, brattice, cotton
- b. MIL-A-3316 Adhesives, fire-resistant, thermal insulation
- c. MIL-B-19 564 Bedding compound, thermal insulation pipe
- d. MIL-C-20079 Cloth, glass, tape textile glass, and thread

15-5.2.5 Air Moving and Conditioning Association Bulletin

- a. 210 Standard test code for air moving devices

15-5.2.6 American Society of Heating, Refrigeration and Air Conditioning Engineers Publications

- a. Guide and Data Book - Applications
- b. Guide and Data Book - Fundamentals and Equipment

15-5.2.7 National Fire Protection Association Standards

- a. No. 90A Air conditioning and ventilating systems for other than residence type

15-5.2.8 American Association of Home Appliance Manufacturers.

- a. CN1 Room air conditioners

15-5.2.9 FAA Standards

- a. FAA-C-1217 Electrical work, interior

15-5.2.10 Underwriters' Laboratories, Inc., Standards

- a. Building Materials List
- b. Electrical Appliance and Utilization Equipment List

15-5.2.11 Air Conditioning and Refrigeration Institute Standards

- a. No. 210 and Unitary air conditioning equipment
No. 260

15-5.2.12 American Standards Association

- a. B9.1 Safety code for mechanical refrigeration

15-5.3 Reference Material- Secure three (3) copies of operating and maintenance instructions, service manuals, and parts lists applicable to each item of equipment furnished. Deliver three (3) bound sets for the Owner's use. Include nameplate data and design parameters in the operation and maintenance manuals. Clearly distinguish between information which applies to the equipment and information which does not apply. Delivery of required documents is a condition of final acceptance.

15-5.4 Materials and Equipment - Materials and equipment shall conform to the respective publications and other requirements specified below. Other materials and equipment shall be as specified elsewhere herein and as shown on the drawings and shall be the products of the manufacturers regularly engaged in the manufacture of such products. Items of equipment shall essentially duplicate equipment that has been in satisfactory use at least 2 years prior to bid opening and shall be supported by a service organization that is reasonably convenient to the site. Submit shop drawings, maintenance manual, and parts lists as specified in these specifications.

15-5.4.1 Escutcheons - Escutcheons in unfinished spaces shall be 20-gage (0.0396-inch in nominal thickness) Stainless Steel-disk type. Escutcheon. Plates shall be large enough to cover holes around pipe or insulation.

15-5.4.2 Insulation - All insulating material including adhesives, mastic, vapor barrier, and brattice cloth, shall be non-combustible and non asbestos as defined in the National Building Code, Section 200, and shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50 as defined in the Standard Test Method for Fire Hazard Classification in the Building Materials List of the Underwriters' Laboratories, Inc. **Provide submittal.**

15-5.4.2.1 External Duct Installation – N/A

15-5.4.4 Sheets, Metal

15-5.4.4.1 Aluminum Sheets - Federal Specification QQ-A-250 half-hard condition, H14 and H24 temper, or Military Specification MIL-A-52174. Gage numbers specified hereinafter refer for aluminum sheets to Brown and Sharpe Gage.

15-5.4.4.2 Iron and Steel Sheets - Gage numbers specified hereinafter refer to United State Standard gage.

15-5.4.4.2.1 Furniture Steel - Federal Specification QQ-S-700.

15-5.4.4.2.2 Galvanized - Federal Specification QQ-S-775, Class D.

15-5.4.4.2.3 Un coated - Federal Specification QQ-S-698.

15-5.5 Conformance to Agency Requirements - Where materials or equipment are specified to be approved by the Underwriter's Laboratories, Inc., or constructed and/or tested in accordance with the standard of the American Society of Mechanical Engineers or the Air Moving and Conditioning Association, submit proof that the items furnished under this section of the specifications conform to such requirements. The label of or listing by the Underwriters' Laboratories, Inc., will be acceptable as sufficient evidence that the items conform to such requirements. The ASME stamp or the AMCA label will be acceptable as sufficient evidence that the items conform to the respective requirements. In lieu of such stamp, label, or listing, except ASME stamp, submit a written certification from any nationally recognized testing agency adequately equipped and competent to perform such services, stating that the items have been tested and that the units conform to the requirements listed hereinbefore, including methods of testing of the specified agencies.

15-5.6 Guarantee - All work hereunder shall be guaranteed for two years against all defects in materials and workmanship. In addition, certain items of equipment (such as small sealed refrigeration units) shall be covered by the manufacturer's warranty of longer duration. This includes oiling, refrigerant, refrigerant charging, filters, filter changing, and any other service required to make the system operational during the warranty period.

15-5.7.4 Replacement of Equipment - Should any piece of apparatus or any materials or work fail in any of these tests, it shall be immediately removed and shall be replaced by perfect material, and the portion of the work replaced shall again be tested at contractor's own expense.

15-5.7.5 Filters/Condensate Traps - Both A/C units shall not be operated until filters and condensate traps are installed. **Traps shall be copper only.**

15-5.7.6 Inspection - Make an inspection during the opposite season from that in which the initial adjustments were made and at that time make necessary modifications to initial adjustments required to produce operation of the system components, and to produce the proper conditions in each conditioned space.

15-5.7.8 Standards - Inspection and check procedures outlined in ARI Standard 260 shall be performed.

15-5.7.9 Submittal data and shop drawings -

15-5.7.13.1 Shop drawings - Shall be provided on all equipment specified in this section and shall be in accordance with the application sections and general provisions of this specification. All shop drawings submitted pertaining to major equipment items such as but not limited to, air handlers, condensers, ductwork, electrical wiring etc. shall include the particular items drawn on minimum 1/4-inch scale blue line backgrounds complete with a minimum of one sectional view indicating sufficient information to ensure compatibility with physical constraints, manufacturer required maintenance and code clearances, and indication of noninterference with work installed by other trades.

15-5.7.13.2 Instruments - In performing the air balance and adjustment work, use calibrated instruments as approved by the COTR.

15-5.7.14 Acceptance -.

15-5.7.15 Operating Instructions and Maintenance Schedules - Furnish the Contracting Officer with three typed sets per site of complete operating instructions and maintenance schedules. Operating instructions shall first be submitted to the COTR for approval. Maintenance schedules shall include, but not be limited to, complete lubricating instructions designating all oiling and greasing points for all equipment and designating type of lubricant to be used.

15-5.9 Sheet Metal Work

15-5.9.1 General - All duct work shall be constructed of galvanized steel or aluminum sheets. **The use of round duct shall be used as shown on the plans if applicable.** Gage for steel ducts shall be U. S. Standard and gage for aluminum shall be B & S. Unless otherwise approved, ducts shall conform accurately to the dimensions indicated and shall be straight and smooth on the inside, with joints neatly finished. Ducts shall be anchored securely to the building in an approved manner and shall be so installed as to be completely free from vibration under all conditions of operation. Square elbows shall be fabricated as detailed on the plans. Curved elbows shall have a centerline radius of 1 1/2 times with width of the duct. Joints shall be made substantially airtight, and no dust marks from air leaks shall show at duct joints or connections to grilles and diffusers. Laps shall be made in the direction of airflow. Edges and slips shall be hammered down to leave a smooth interior duct finish. Button or bolt connections in standing seams shall be spaced at fixed centers not greater than 6 inch spacing. Transformations shall be made with a slope ratio of 7:1, or in a specifically approved manner. Ducts with one side over 12 inches shall have cross break to assure rigidity in the duct section. All metal and flex duct shall be made air tight at the seams and joints. **Use a Duct Seal type coating on all duct joints to prevent air leakage.** Turning vanes shall be provided on all 90 degree bends. The control dampers located in the supply duct system shall be manual type. All joints shall be sealed and made air tight per SMACNA. **Bottom Line: seal all duct leaks.**

15-5.9.2 Duct Supports (Rigid/Flex) - Unless otherwise shown, supports shall be not less than 1 inch by 16 gage galvanized strap-iron hangers. Hangers shall be anchored on each side of the duct with one screw on bottom and at least one on the side. Hangers shall be spaced not over 3 feet on center. Anchor ducts securely to prevent vibration

under all conditions of operation. Flex duct shall be fully supported and shall not lay on ceiling tiles. Contractor shall comply with SMACNA Duct construction Standards Metal and Flexible.

15-5.9.3 Ducts and Stiffeners - Construct ducts and stiffeners of galvanized steel or aluminum sheet, of thickness and fabrication as indicated in SMACNA Duct Manual and Sheet Metal Construction, Section 1, Low Velocity Systems.

15-5.9.4 Duct Test Holes and Inspection Openings - Holes in ducts and plenums shall be provided for each branch supply from the roof top unit and the return duct and elsewhere as directed or necessary for using pitot tubes for taking air measurements to balance the air systems. At each of these locations where ducts or plenums are insulated, extension shall be provided with plug fittings. Test holes shall be standard manufactured product.

15-5.9.5 Apparatus Connections - Where sheet-metal connections are made to roof top units, or where ducts of dissimilar metal are connected, a flexible connection of 29 ounce neoprene-coated fiberglass shall be provided. Flexible connections shall be securely fastened by stainless steel metal adjustable bands. Connections shall be approximately 6 inches in width, and shall have one-inch slack provided.

15-5.9.6 Dimensions - All dimensions shown on the drawings indicate actual inside diameter sheet metal dimensions.

15-5.9.7 Flexible Duct Connections – See duct specifications above.

15-5.10 Diffusers, Registers, Rain Hoods and Grilles

15-5.10.1 General - All supply diffusers shall be furnished by the contractor. The contractor shall supply the return air grills where shown on the plans or as directed by the FAA COTR. **Use Tuttle and Bailey Type registers and grilles.**

15-5.10.2 Outlets - **Supply diffusers shall be arranged for discharge, as indicated on the plans or as directed by the FAA COTR. Sponge-rubber gasket shall be provided between the main duct and diffuser or rim. Duct collar connecting the duct to diffuser shall fit inside of diffuser neck. Connections between the duct work and diffusers shall be made air tight. All external duct insulation shall be drawn over the connection as well and the metal band shall be used to fasten the system together.**

15-5.11 Insulation – **No Duct insulation is required.**

15-5.11.1 Rain Hoods - N/A

15-5.11.2 Inspection openings: The contractor shall install an inspection opening in each duct run. The opening shall be sufficiently large enough for a technician to inspect the entire duct run. The inspection door shall conform to SMACNA duct construction stds.

15-5.11.2.1 Lap Adhesive - MIL-A-3316, Type III.

15-5.11.2.2 Lagging Adhesive - MIL-A-3316, Type II.

15-5.11.2.3 Puncture and Abrasive Resistant Lagging Adhesives - MIL-A-3316, Type I.

15-5.11.2.4 Brattice Cloth - MIL-C-7 fire retardant and mildew inhibited.

15-5.11.2.5 Knitted Glass Lagging Tape - MIL-C-20079, Class C.

15-5.11.2.6 Joint Sealing Material - MIL-B-19564.

15-5-13 DUCT INSULATION N/A

15-5.21 Controls - The controls necessary for the operation of the equipment shall be furnished by the manufacturer sufficient to maintain temperature and proper operation of the system. The liebert Large Icom system shall be part of the Liebert system and interconnection between both units shall be provided by the contractor.

15-5.21.2 General - Controls furnished by the manufacturer shall be factory installed for a single electrical connection, except the following which shall be field installed - return air thermostat remote adjuster for return air thermostat, air conditioning panel for the unit, with indicating lights and stop-start switch control.

15-5.21.3 Panel N/A

15-5.23 Variable Air Volume Terminal Units - N/A

15-5.23.6 Submittals -

15-5.23.7 Operation And Maintenance Data- Furnish all operations and maintenance manuals in a three hole binder. A minimum of three copies is required.

15-5.23.8 System Responsibility

- a. The contractor shall be responsible for any and all costs associated with any and all changes resulting from field changes to the duct system or intake and exhaust louver system. The contractor will be responsible for demonstrating the system operation and ensure that the change will work.
- b. Provide one year warranty for workmanship and products for items supplied by the contractor including the labor to install the A/C units.

15-5.24.1 Sequence Of Operation for A/C units

1. Main supply fan shall be set to run continuously.
2. Space thermostat will control operation of A/C unit compressors to provide cooling as needed.
3. Automatic controls shall shut down the units if a system problem is observed.

15-6 ACCESS DOORS

15-6.1 General.- Provide and install access doors in all wall or ceiling locations as required for access to volume dampers or other in-duct controls.

15-6.1.1 Scope.-

15-6.2 Applicable documents.- Not Used.

15-6.3 Materials. - Access doors shall be with 16-gage frames, 14-gage panels, 22-gage casing head. Furnish with factory applied prime coat of paint, concealed hinges and flush screwdriver-operated cam lock. Use Style M access doors for gypboard surfaces, Style B access doors for acoustical plaster ceilings, with 18-gage panel and all-galvanized construction. Use doors in floor and ceiling assemblies designed and installed so as not to reduce the flame resistant rating of the assembly. Provide fire rated doors in fire rated assemblies. Doors shall have laboratory tested ratings equal to or greater than the assembly in which they are installed. Use Style M stainless steel access doors for tiled surfaces. A known acceptable source is: Imryco/Milcor or approved equal.

15-6.4 Installation.-

15-6.4.1 Doors furnished by this contractor will be installed by other crafts. Not all required access doors are shown. The General Contractor shall be responsible for proper coordination with the Contractors in locating access doors for ease of operation and maintenance of concealed equipment.

15-6.4.2 Marking.- On the front face of the access door, stencil in 2-inch-high letters the description of the associated device being served.

15-6.5 Quality assurance.-

15-6.5.1 Submittals.-

- (a) Manufacturer's catalog data

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15-7 VIBRATION ISOLATION

15-7.1 General.-

15-7.1.1 Scope.- This section specifies furnishing, installing, and adjusting vibration isolation equipment.

15-7.1.2 Related work in other sections.-

Section 15-24:	Air-Cooled Condensers
Section 15-27:	Fans
Section 15-28:	Ductwork
Section 15-33:	Split-System Fan Coil Units
Section 15-36:	Refrigerant Piping and Appurtenances

15-7.2 Applicable documents.- Not Used.

15-7.3 Material.-

15-7.3.1 Materials.- Provide treated vibration isolators for resistance to corrosion. Furnish phosphatized steel components with industrial- grade, corrosion-resistant enamel. Coat components exposed to the weather with PVC coating or fabricate of galvanized steel. Furnish zinc electroplated nuts, bolts, and washers. Clean steel bases thoroughly of welding slag and prime with zinc-chromate or metal etching primer.

15-7.3.1.1 Design.-

- (a) Unless noted otherwise, use spring-type vibration isolators for all equipment driven by motors of 5 horsepower and larger. The isolator manufacturer must calculate the amount of spring deflection required for each isolator to achieve optimum performance and to prevent the transmission of objectionable vibration and noise.
- (b) Isolators for equipment installed outdoors shall provide adequate restraint due to normal wind conditions at the particular sited location. The isolators must withstand minimum wind loads of 30 pounds per square foot applied to any exposed surface of the isolated equipment.

15-5.7.7 Noise and Vibration - All air handling (interior AHU) equipment shall be placed on spring isolation pads located between the floor stand and the floor. The spring isolation device shall be bolted to the floor using concrete anchor bolts. The outside condensers shall be bolted to the concrete bases. All ducts exiting from the air handlers shall have flex duct collars between the unit and the supply duct. If objectionable noise or vibration is produced or transmitted to or through the building structure by equipment, ducts or other parts of work, rectify such conditions without cost to the Owner. If the item of equipment is judged to produce objectionable noise or vibration, demonstrate without cost to the Owner the equipment performs within designated limits on the vibration chart. Highest allowed levels of background noise due to operating equipment provided under this specification shall be NC 40 for electronic equipment rooms, and NC 50 for storage and equipment rooms.

15-7.3.4.4 Seismic Restraint.- Shall be per SMACNA / ASHRAE code.

15-7.4 Installation

15-7.4.1 Installation of vibration isolation devices.-

(a) General

1. Transmission of perceptible, vibration, structure borne noise to occupied area by equipment installed under this Contract will not be permitted.
2. All vibration isolation devices, including auxiliary steel bases and pouring forms, shall be designed and furnished by a single manufacturer, or supplier, who will be responsible for adequate coordination of all phases of this work.
3. The vibration isolation manufacturer, or his representative, shall be responsible for providing such supervision as might be necessary to assure correct installation and adjustment of the isolators. Upon completion of the installation and after the system is put into operation, the manufacturer, or his representative, shall make a final inspection and submit his report to the Contracting Officer's Representative in writing, certifying the correctness of installation and compliance with approved submittal data.
4. The contractor shall not install any equipment or pipe which makes rigid contact with the "building" unless it is approved in this specification or by the Architect. "Building" includes slabs, beams, studs, walls, lathe, etc.

15-7.4.2 Electrical connections to resiliently mounted equipment.- Electrical connections to equipment which is supported or suspended by vibration isolators shall be made with long lengths of flexible conduit or flexible armored cable. These flexible connections must be located so as to prevent rigid connections between the resiliently mounted equipment and the building structure.

15-7.4.3 Suspended vibration isolated equipment.- N/A

15-7.4.4 Vibration isolated piping.- Use a slack cable system cable shall be installed with sufficient slack to avoid short circuiting of the vibration isolation.

15-7.5 Quality assurance.-

15-7.5.1 Submittals.- Submit manufacturer's catalog data showing type, size, load, deflection and other information required. Include clearly outlined procedures for installing and adjusting isolators.

15-7.10.3 Stock requirements.- The isolation manufacturer's representative shall maintain an adequate stock of springs and isolators of type used so that changes required during construction and installation can be made with minimum delay.

* * * *

15-23 COMPUTER ROOM AIR CONDITIONING UNITS

15-23.1 General.-

15-23.1.1 Scope.- This section specifies vertical air handler evaporator units AHU-1 and 2.

15-23.1.2 Related work in other sections.-

Section 15-7: Vibration Isolation

Division 16: Electrical

15-23.1.3 Performance.- Unit capacities and characteristics are as scheduled on the drawings.

15-23.2 Applicable documents.- The following specification and standards, of the issues currently in force, form a part of this section and are applicable as specified herein.

15-23.2.1 Air Conditioning & Refrigeration Institute (ARI).-

240 Air-Source Unitary Heat Pump Equipment

15-23.2.2 American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE)..-

52 Method of Testing Air-Cleaning Devices used in General Ventilation for Removing Particulate Matter

15-23.3 Materials.- All A/C equipment and associated installation needs will be contractor supplied.

15-23.3.1 CRU-1, 2 These units shall have **30 tons of total cooling** and shall consist of a separate air handler and condensing section. **Voltage is 208/3ph/60hz.**

15-23.3.1.1 Assembly.-

Fan Section

The fans shall be the centrifugal type, double width double inlet, and shall be statically and dynamically balanced as a completed assembly to a maximum vibration level of two mils in any plane. The shaft shall be heavy duty steel with self-aligning ball bearings with a minimum life span of 100,000 hours. The fan motor shall be 20 hp at 1750 RPM and mounted on an adjustable slide base. The drive package shall be multi-belt, variable speed, sized for 200% of the fan motor horsepower. The fans shall be located to draw air over the A-Frame coil to ensure even air distribution and maximum coil performance.

Reheat Electric

The electric reheat coils shall be low watt density, 304/304 stainless steel fin tubular construction, protected by thermal safety switches, shall be controlled in three stages.

Compressorized Systems

Dual Refrigeration Systems

Each refrigeration circuit shall include hot gas mufflers, liquid line filter dryers, refrigerant sight glass with moisture indicator adjustable, externally equalized expansion valves, and liquid line solenoid valves.

Semi-Hermetic Compressors

The compressors shall be located in a separate compartment so they may be serviced during operation of the equipment. The compressor shall be semi-hermetic with a suction gas cooled motor, vibration isolators, thermal overloads, oil sight glass, manual reset high pressure switch, pump down low pressure switch, suction line strainer, reversible oil pumps for forced feed lubrication, a maximum operating speed of 1750 RPM, and a minimum EER of _____.

Four-Step Refrigeration System

The environmental control system shall include cylinder unloaders on the semi-hermetic compressors. The unloaders shall be activated by solenoid valves which are controlled from the microprocessor control. In response to the return air temperature, the microprocessor control shall activate the unloader solenoids and the liquid line solenoids such that four stages of refrigeration cooling are obtained. The stages shall be: **1)** one compressor, partially loaded, **2)** two compressors partially loaded, **3)** one compressor partially loaded, one compressor fully loaded, **4)** two compressors fully loaded. On a call for dehumidification, the microprocessor control shall insure that at least one compressor is on full for proper humidity control.

A-Frame DX Coil

The evaporator coil shall be an A-Frame design. Refrigerant of each system shall be distributed throughout the entire coil face area. A stainless steel condensate drain pan shall be provided.

Lee-Temp Winter Control System (Optional)

The winter control system for the air cooled condenser shall be Lee-Temp. The Lee-Temp system shall allow start-up and positive head pressure control with ambient temperatures as low as -30°F (-34.4°C). The Lee-Temp package shall include the following components for each refrigeration circuit: insulated receiver, pressure relief valve, head pressure three-way control valve, and rotalock valve for isolating the refrigerant charge. The Lee-Temp receiver shall be factory insulated and mounted ready for the field connection to the air cooled condenser. The Lee-Temp heater shall require a separate power supply of 208 volt, single phase.

Quiet-Line Condenser

Fan motors shall be 12-pole, 570 RPM, equipped with rain shields and permanently sealed ball bearings. Motors shall include built-in overload protection. Motors shall be rigidly mounted on die-formed galvanized steel supports. Disconnect switch shall be a standard feature.

Vertical Up Flow air conditioning units (AHU-1, AHU-2) are factory assembled units. Include heresite coatings on evaporator and condenser coils. Furnish minimum 18- gage steel insulated cabinets which are corrosion-resistant treated before final finish is added. Provide knockouts for piping and electrical connections as required. Make provision for duct collar connections at each (supply/return) end of the unit as indicated on drawings. Provide units with vibration isolation in accordance with Section 15-7, VIBRATION ISOLATION.

15-23.3.1.1.2 Refrigerant piping- Each unit shall be piped using the trapping as shown on the drawings. Use flex connections for each piping, suction and discharge lines to allow piping to move. (see drawings for detail)

15-23.3.1.4 Drain pan.- Provide heavy-duty, insulated drain pans of 18-gage welded Stainless Steel. Each pan shall be supplied with a drain nipple and a separate trap/drain shall be installed for the pan only. The pan shall be located between the air handler and the floor stand. The pan shall have a separate drain.

15-23.3.15 Filters.-

- (a) **Filters.** Air filters shall be 2-inch throw-away type. Size and capacity to be coordinated with units. Provide minimum 30 percent efficiency as per ASHRAE 52 for arrestance of 90 percent (minimum).
- (b) **Provide size and quantity of filters as required to match plenum size.**
- (c) **Provide three sets of extra filters to be used for spares and leave them at the site.**

15-23.4 Installation.-

15-23.4.1 Install according to the manufacturer's recommendations and as shown on the drawings. Units shall be isolated with vibration isolators and canvas flexible connectors from mounting supports and ductwork to eliminate any transmission of noise or vibration. The contractor shall hire a certified Rigging company to place all new A/C equipment. The contractor shall have the same rigger off load the units at delievery to the site.

15-23.4.2 Floor Stands- Each air handler unit shall be mounted on a separate floor stand as shown on the drawings. Provide floor stands six inches off floor. Purchase factory made floor stands only.

15-23.5 Quality assurance.- Provide one year parts and labor warranty for units (AHU-1 and AHU-2)

15-24 Condenser Section-

15-24.1 Condenser Section Installation - The outside condenser sections shall be mounted to the concrete pad and leg extensions of four feet shall be added to each leg. The legs shall be bolted directly to the concrete pad.

15-24-2 Low Temperature Devices – Each condensing unit shall be provided with a “Lee” type low temperature device for operations down to –30F. See drawings for details.

15-24-3 Refrigerant Piping - **Each unit shall be piped using the trapping as shown on the drawings. Use flex connections for all piping runs including, suction and discharge lines.**

15-30 TESTING AND BALANCING

15-30.1 General.-

15-30.1.1 Scope.- This section covers final air and water balance operations to the building after construction of the air and water systems. Refer to section 15-1 MECHANICAL GENERAL PROVISIONS for allowable noise levels.

15-30.2 Applicable documents.- The following specification and standards, of the issues currently in force, form a part of this section and are applicable as specified herein:

15-30.2.1 American National Standards Institute (ANSI).-

S1.4 Sound Level Meters

15-30.2.2 Associated Air Balance Council (AABC).-

A-89 National Standards for Testing and Balancing

15-30.2.3 National Environmental Balancing Bureau (NEBB).-

Standards for Testing and Balancing

15-30.3 Materials.- Not used.

15-30.4 Installation.-

15-30.4.1 Air balance (By Air Balance Agency).-

15-30.4.1.1 Procedures for air balance.- Procure the services of an independent air balance and testing agency, a member of the AABC or NEBB, to perform complete balance, adjustment and testing of air moving equipment and air distribution systems. Submit the agency name for approval by the Contracting Officer's Representative. Accomplish work under the supervision of a qualified registered air conditioning and ventilating engineer employed by the balance and testing agency. Use instruments that are accurately and recently calibrated and maintained in good working condition, as listed by AABC. Provide the Contracting Officer's Representative with complete test plan 60 days prior to the start of work.

- (a) Do not begin balancing and testing until systems have been completed, cleaned and are in full working order. Replace dirty filters with new filters. Do not operate any fan system without the complete set(s) of related filter media installed as applies. Put all systems into full operation and continue during each working day of balancing and testing. Ensure that all lights are on during testing.
- (b) Supervise or perform necessary adjustments to manual and automatic air flow dampers, fan sheaves and pulleys, extractors, controls, splitters and the like.
- (c) Compile the test data on a report form, similar to AABC forms, upon completion of balancing and testing. Submit 4 copies for review and approval by the Contracting Officer's Representative.
- (d) Follow balancing and testing procedures published by AABC A-89. Completed report form shall be signed by the individual testing agent certifying the test and balance.

- (e) Once the balancing operation is finalized, all balance point settings shall be permanently marked. No pencil marks shall be permitted.
- (f) The testing and balancing contractor shall perform his work in cooperation with the controls contractor to ensure the system is operating correctly.

15-30.4.1.2 Test procedure for air systems.- The Testing Agency shall perform the following tests, and balance systems in accordance with the following requirements.

- (a) Check and adjust fan rpm to design requirements and record fan motor amperes.
- (b) Test and record fan motor amperes at design rpm.
- (c) Make pitot tube traverse of main supply ducts and adjust fan rpm to obtain design CFM (cubic feet per minute).
- (d) Test, adjust and record system static pressures, suction and discharge ducts.
- (e) Test and adjust system for design recirculated air CFM.
- (f) Test and adjust system for design CFM outside air (minimum and maximum).
- (g) Test and record entering air temperatures (D.B. Heating and Cooling).
- (h) Test and record entering air temperatures (W.B. Cooling).
- (i) Test and record leaving air temperatures (D.B. Heating and Cooling).
- (j) Test and record leaving air temperatures (W.B. Cooling).
- (k) Adjust all main supply and return air ducts to proper design CFM.
- (l) Adjust all zones to proper design CFM, supply and return (as applies).
- (m) Test and adjust each diffuser, and register to within ten (10) percent of design requirements (as applies).
- (n) Each diffuser, and register shall be identified as to location and area. Size, type, and manufacturer of diffusers, registers, and all tested equipment shall be identified and listed. Manufacturer's ratings on all equipment shall be used to make required calculations. Readings and tests of diffusers and registers shall include required fpm (feet per minute) velocity and test resultant velocity, required CFM and test resultant CFM after adjustments. In cooperation with the temperature control manufacturer's representative, the setting adjustments of automatically operated dampers shall be set to operate as specified, indicated, and as noted.
- (o) The air balance and testing agency shall check all controls for proper calibration and list all controls requiring adjustment by control installers.
- (p) All diffusers and registers shall be adjusted to minimize drafts in all areas.

- (q) All fans shall be tested and adjusted to meet the design requirements and final ampere readings shall be taken and recorded.
- (r) As a part of the Work of this Contract, the Contractor shall make any adjustments to the pulleys, belts, and dampers, or the addition of dampers required for correct balance, as recommended by the Testing Agency, at no additional cost to Owner.
- (s) Perform air pattern tests with smoke bombs in areas requested by the Contracting Officer's Representative.

15-30.4.2 Testing procedure for sound levels.-

- (a) Using recently calibrated instruments, conduct sound level tests. Measure sound level readings in decibels on the "A" and "C" scales on a sound level meter that meets the current ANSI S1.4 based on the acoustic reference power of DB (re: 10-12 watts). Readings shall set forth the total random sound level with the system in operation, as compared to total background sound level with the system not in operation. The system increase over the background level shall be recorded in decibels on the "A" and "C" scales. The measured noise levels within the spaces tested shall not exceed those specified in Section 15-1 of this specification with all HVAC related equipment in operation. Octave band analysis shall be performed to ensure the stipulated NC levels are complied with (i.e. not exceeded).
- (b) Identify each outlet by room name, room number and air outlet number.
- (c) Measure and record sound levels in decibels at each diffuser, grille and register. Measure sound levels approximately five feet above the floor on a line directly below (or in front of - in the case of sill or sidewall devices) the center of the diffuser, etc., on the "A" and "C" scales.
- (d) Tabulate data for all occupied rooms.

15-30.4.4 Reports.- Include four copies of final balance and test reports with the following data:

- (a) Tabulate final air volumes at supply and return air diffusers, grilles and registers. Include exhaust grilles, other than toilet exhaust, and exhaust hoods, where applicable.
- (b) Record temperatures indoors and outdoors.
- (c) Record entering and leaving dry bulb temperatures of air handling units.
- (d) Calculate fan sound power (L_w) and sound pressure (L_p) levels on suction and discharge connections and provide all supporting data.
- (e) Submit sound data for all rooms tested.
- (f) Electrical motor load data.

15-30.5 Quality assurance.-

15-30.5.1 Warranty.- Within 90 days after completion of balancing and testing, the Contracting Officer's Representative may request a recheck or resetting of any outlet or fan listed in test report. Provide technicians and equipment necessary to assist the engineer as required in making tests during this period.

15-30.5.2 Control cab system air balancing and adjustment.- The Contractor shall exercise particular attention to the proper air balance of the control cab air conditioning system. The control cab system shall be properly adjusted to achieve actual air quantities within plus or minus five (5) percent of the design air requirements. The Contractor shall use carefully calibrated instruments as approved by the Contracting Officer's Representative. The control cab system shall not be considered completely adjusted or balanced until approved and accepted by the Contracting Officer's Representative or his representative.

15-30.5.3 All balancing and testing shall be witnessed by the Contracting Officer's Representative or his representative. Submit to the Engineer a complete test log of the system performance for all of the tested systems including all static pressures, grille velocities, temperatures, control positions for valves, dampers, set point adjusters, switches, stats, etc., as well as supply, exhaust, and return air quantities for each air handling unit or fan device as applies.

15-30.5.4 Submittals.-

- (a) Agency name
- (b) Test plan
- (c) Test log
- (d) Balance and Test Report

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15-31 CONTROL SYSTEMS - ELECTRIC AND ELECTRONIC

15-31.1 General.-

15-31.1.1 Scope.- Provide a complete system of automatic temperature control and smoke relief (where applicable), including instrumentation necessary to obtain functions and results specified. Furnish a complete system including, but not limited to, items such as thermostats, humidistat, dampers, temperature sensing elements, flow and pressure sensing elements, element wells, regulators, relays and control wiring. Unit controls shall be fully integrated with known acceptable sources such as: Johnson Controls.

Advanced Control Processor (Supplied with A/C Units)

The **ICOM Large panel control processor** shall be microprocessor based with a front monitor LCD display panel and control keys for user inputs. The controls shall be menu driven with on-screen prompts for easy user operation. The system shall allow user review and programming of temperature and humidity setpoints, alarm parameters, and setup selections including choice of control type. A password shall be required to make system changes. For all user selections, the range of acceptable input (temperature, humidity, or time delay) shall be displayed on the monitor screen. The system shall provide monitoring of room conditions, operational status in % of each function, component run times, date and time, and four analog inputs from sensors provided by others.

Control

The control system shall allow programming of the following room conditions:

- **Temperature Setpoint—65–85°F (18–29°C)**
- **Temperature Sensitivity—±1° to 9.9°F (0.6 to 5.6°C) in 0.1°F (.1°C) increments**
- **Humidity Setpoint—20–80% RH**
- **Humidity Sensitivity—+1% to +30% RH**

All setpoints shall be adjustable from the individual unit front monitor panel. Temperature and Humidity Sensors shall be capable of being calibrated using the front monitor panel controls to coordinate with other temperature and humidity sensors in the room.

Predictive Humidity Control

The microprocessor shall calculate the moisture content in the room and prevent unnecessary humidification and dehumidification cycles by responding to changes in dew point temperature. In addition, the system shall provide the following internal controls:

Compressor Short-Cycle Control

The control system shall include a program to prevent compressor short cycling.

Automatic Compressor Sequencing

The microprocessor shall automatically change the lead/lag sequence of the compressors after each start to lengthen compressor-on cycles and even compressor wear.

System Auto-Restart

For start-up after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6-second increments) time delay. Programming can be performed either at the unit or from the central site monitoring system.

Sequential Load Activation

During start-up, or after power failure, the microprocessor shall sequence operational load activation to minimize inrush current. Systems allowing multiple loads to start simultaneously are unacceptable.

Front Monitor Display Panel

The microprocessor shall provide a front monitor LCD backlit display panel with 4 rows of 20 characters with adjustable contrast. This display (along with five front mounted control keys) shall be the only operator interface required to obtain all available system information such as room conditions, operational status, alarms, control and alarm setpoints, and all user selections including alarm delays, sensor calibration, DIP switch selections, and diagnostics. All indicators shall be in language form. No symbols or codes shall be acceptable.

Alarms

The microprocessor shall activate an audible and visual alarm in event of any of the following conditions:

High Temperature

- Low Temperature
- High Humidity
- Low Humidity
- Short Cycle
- Compressor
- Overload (#1 and #2) (opt)
- Main Fan Overload (opt)
- Humidifier Problem
- High Head Pressure (#1 and #2)
- Change Filters
- Loss of Air Flow
- Low Suction Pressure
- Loss of Power
- Custom Alarm (#1 to #4)

Custom alarms are four customer accessible alarm inputs to be indicated on the front panel. Custom alarms can be identified with prepared (programmed) labels for the following frequently used inputs:

- Water Under Floor
- Smoke Detected
- Standby GC Pump On
- Standby Unit On

User customized text can be entered for two of the four custom alarms.

Each alarm (unit and custom) can be separately enabled or disabled, selected to activate the common alarm, and programmed for a time delay of 0 to 255 seconds.

Audible Alarm

The audible alarm shall annunciate any alarm that is enabled by the operator.

Common Alarm

A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.

Remote Monitoring

All alarms shall be communicated to the Liebert site monitoring system with the following information: date and time of occurrence, unit number, and present temperature and humidity.

Control Type

The user shall be able to select the type of control the advanced microprocessor will use. Selections available shall be intelligent, proportional, and tunable PID (proportional, integral, and derivative gains). The intelligent control

shall incorporate control logic that uses artificial intelligence techniques including “fuzzy logic” and “expert systems” methods to maintain precise, stable control. If tunable PID is selected, the user shall be able to program each of the three gains.

Analog Inputs

The system shall include four customer accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20 mA signal. The user shall be able to change the input to 0 to 5 VDC or 0 to 10 VDC if desired. The gains for each analog input shall be programmable from the front panel. The analog inputs shall be able to be monitored from the front panel.

Diagnostics

The control system and electronic circuitry shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as on or off at the front monitor panel.

Control outputs shall be able to be turned on or off from the front monitor panel without using jumpers or a service terminal.

Data Collection

The control system shall maintain accumulative operating hours of compressors, reheats, humidifier, fan motor and Econ-O-Coil. The ten most recent alarms shall also be retained.

Communications

The microprocessor shall be compatible with all Liebert remote monitoring and control devices.

wear.

System Auto-Restart

For start-up after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6-second increments) time delay. Programming can be performed either at the unit or from the central site monitoring system.

Sequential Load Activation

During start-up, or after power failure, the microprocessor shall sequence operational load activation to minimize inrush current.

Systems allowing multiple loads to start simultaneously are unacceptable.

Front Monitor Display Panel

The microprocessor shall provide a front monitor 240 x 128 dot matrix graphics display panel with backlighting. This display (along with five front mounted control keys) shall be the only operator interface required to obtain all available system information such as room conditions, operational status, graphical data, alarms, control and alarm set-points, and all user selections including alarm delays, sensor calibration, DIP switch selections, and diagnostics. All indicators shall be in language form. No symbols or codes shall be acceptable.

Alarms

The microprocessor shall activate an audible and visual alarm in event of any of the following conditions:

- High Temperature
- Low Temperature
- High Humidity
- Low Humidity
- Short Cycle
- Compressor

Overload #1 and #2 (Opt)
Main Fan Overload (Opt)
Humidifier Problem
High Head Pressure (#1 and #2)
Change Filters
Loss of Air Flow
Low Suction Pressure
Loss of Power
Custom Alarm (#1 to #4)

Custom alarms are four customer accessible alarm inputs to be indicated on the front panel. Custom alarms can be identified with prepared (programmed) labels for the following frequently used inputs:

Water Under Floor
Smoke Detected
Standby GC Pump On
Loss of Water Flow
Standby Unit On

User customized text can be entered for all four custom alarms.

Each alarm (unit and custom) can be separately enabled or disabled, selected to activate the common alarm, and programmed for a time delay of 0 to 255 seconds.

Audible Alarm

The audible alarm shall annunciate any alarm that is enabled by the operator.

Common Alarm A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device.

Remote Monitoring

All alarms shall be communicated to the Liebert site monitoring system with the following information: date and time of occurrence, unit number, and present temperature and humidity.

Control Type

The user shall be able to select the type of control the advanced microprocessor will use. Selections available shall be intelligent, proportional, and tunable PID (proportional, integral, and derivative gains). The intelligent control shall incorporate control logic that uses artificial intelligence techniques including “fuzzy logic” and “expert systems” methods to maintain precise, stable control. If tunable PID is selected, the user shall be able to program each of the three gains.

Analog Inputs

The system shall include four customer accessible analog inputs for sensors provided by others. The analog inputs shall accept a 4 to 20 mA or 0 to 10 VDC signal. The user shall be able to change the input to 0 to 5 VDC if desired. The gains for each analog input shall be programmable from the front panel. The analog inputs shall be able to be monitored from the front panel.

Diagnostics

The control system and electronic circuitry shall be provided with self-diagnostics to aid in troubleshooting. The microcontroller board shall be diagnosed and reported as pass/not pass. Control inputs shall be indicated as on or off at the front monitor panel. Control outputs shall be able to be turned on or off from the front monitor panel without using jumpers or a service terminal.

Data Collection

The control system shall maintain accumulative operating hours of compressors, reheats, humidifier, fan motor, Econ-O-Coil, and heat rejection. The sixty most recent alarms shall also be retained.

Communications

The microprocessor shall be compatible with all remote monitoring and control devices. The temperature control system shall consist of electric and electronic devices as specified. Provide the type specified for each sequence without exception.

15-31.1.3 Shop Drawings.- Submit items of temperature control equipment, wiring, flow diagrams, sequences, panels and related details for review and approval before starting installation of temperature controls or fabrication of such items as control panels.

15-31.1.4 Composite wiring diagram.- Furnish a complete, detailed, control and interlock wiring diagram. Show mechanical and electrical equipment furnished and electrical interlocks, indicating terminal designation of equipment. Respective equipment manufacturers shall furnish, through the Contractor, approved drawings of equipment to be incorporated in this diagram.

15-31.1.5 Coordination with other trades.-

- (a) Coordinate all equipment to be supplied with integrally mounted control dampers.
- (b) Coordinate with the electrical contractor. Control wiring provided by the mechanical contractor is specified in Division 16.

15-31.2 Applicable documents.- NEMA Standards.

15-31.3 Materials.-

15-31.3.1 Space thermostats.-

15-31.3.1.1 General.- Furnish lock type adjustments on all thermostats unless otherwise shown or specified. Room thermostats shall be single or two stage as required in "Sequence of Operations." Thermometers shall be accurate to plus or minus 2 degrees F. (1 degree C.). Thermostats shall be accurate to plus or minus 1 degree F. (0.55 degree C.), each calibrated for the scale range of 60 to 90 degrees F. (15 to 32 degrees C.). Where thermostats are mounted on exterior walls, they shall be installed on an insulating block backing. Provide sunlight shielding on thermostats exposed to direct sunlight. All programmable thermostats shall have electromagnetic (RFI) shielding..

15-31.3.6 Filter gages.- Provide differential pressure sensing device to sense the pressure drop across each air handling unit filter bank and separate filter banks as scheduled. Provide air filter gages, range 0 to 1.0 inches water, .02 inch minor division, with adjustable signal flag. Surface mount gage on unit or ductwork near filter bank with high and low pressure connections according to manufacturer's recommendations.

15-31.4.2 Sequence of Operations.-

- a. Smoke Detection Shutdown: Upon activation of a duct smoke detector, the air handling units shall shutdown automatically through operation of relay contacts at the smoke detector and an alarm condition shall register at the fire alarm control panel.

15-31.4.2.15.2 Air handling units, supply fans and exhaust fans. - Provide interlocks as indicated or specified in the Sequence of Operations.

15-31.5 Quality control. - After completion of the control installation, calibrate and test thermostats, control valves, motors, damper controllers and other items furnished, subject to approval by the Resident Engineer. Provide five working days advance notice prior to calibration and testing.

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15-33 SPLIT-SYSTEM FAN COIL UNITS

15-33.1 General.-

15-33.1.1 Scope.- This section provides the requirements for furnishing and installing commercial quality manufactured air-cooled split-system air conditioning units marked (CU-1, 2) including all supplemental interconnecting piping and control requirements. Furnish factory tested equipment in the sizes, capacities and arrangements as indicated on the drawings and as specified herein. Equipment shall be ARI Certified. **Liebert Lee-Low temp units with coated coils for salt air.**

15-33.1.2 Related work in other sections.-

Section 15-7:	Vibration Isolation
Section 15-9:	Electric Motors
Section 15-20:	Piping and Piping Appurtenances for Cold Water Make-up and Equipment Drains
Section 15-31:	Control Systems - Electric and Electronic
Section 15-36:	Refrigerant Piping and Appurtenances
Division 16:	Electrical

15-33.1.3 Performance.- Provide equipment with the ability to operate satisfactorily in outdoor temperatures as low as -30 degrees F.

15-33.2 Applicable documents.- The following specification and standards, of the issues currently in force, form a part of this section and are applicable as specified herein:

15-33.2.1 Air-Conditioning and Refrigeration Institute (ARI) Standards. -

210	Unitary Air-Conditioning Equipment
270	Sound Rating of Outdoor Unitary Equipment

15-33.3 Materials.-

15-33.3.1 Unit rating. - Rate in accordance with ARI 210 and 270.

15-33.3.2 Indoor fan coil section.-

15-33.3.2.1 General.- Furnish matched (capacity) fan coil unit of the same manufacturer as the outdoor condensing unit.

15-33.3.2.2 Coils.-

- (a) Evaporator coils shall be designed for direct expansion refrigerant usage (R-407C) and shall be sized for the capacities as scheduled and shall be matched as compatible with the outdoor condensing unit. Coil construction shall be seamless copper tube mechanically bonded to aluminum plate fins. Spine (hair) fins are not acceptable. Coils shall be coated for salt water protection.
- (b) Furnish all equipment with factory installed refrigerant line and coil accessories to include, but not limited to: thermal expansion valves, suction service and charging valves and solenoid shut-off valves (as required).

- (c) Heating coil shall be constructed entirely of copper with the aluminum fins securely bonded to the tubes. The coil shall be designed for use with the media indicated and shall have sufficient surface to provide the capacity indicated on the drawings under specified operating condition. The coil shall be tested pneumatically and proven tight under a pressure of 300 psig or twice the working pressure whichever is greater.

15-33.3.2.3. Motors.-

- (a) Motors shall be multispeed, permanently lubricated squirrel-cage induction type rated for continuous duty, general purpose 40 degree Centigrade operation with electrical characteristics as scheduled on the Drawings. Motors shall be resiliently mounted in casing and in compliance with Section 15-9, ELECTRIC MOTORS.
- (c) Provide all motors with inherent thermal overload protection.

15-33.3.2.4 Blowers.- Provide double-wide-double inlet (DWDI) multiblade forward-curved centrifugal fans. Fans shall be statically and dynamically balanced. Fan bearings shall be of the self-aligning, permanently lubricated type rated for a minimum of 100,000 hours life. For belt-driven blowers, Contractor shall provide to the Contracting Officer's Representative complete fan performance curves marked to indicate selection points. Blowers shall be quiet in operation. Fan capacity shall be as scheduled on the drawings.

15-33.3.2.5 Filters.- Filters shall be standard throw-away media of size and capacity as coordinated with the unit provided. Filter media shall have integral rigid frames and webbing to support media from sagging. Permanent washable media is not acceptable. If factory units do not come equipped with provision for filter frames, provide shop fabricated frames and field install on return air intakes, sized to match opening or to provide for a maximum intake velocity of 500 fpm.

15-33.3.2.6 Drain pan.- Provide heavy duty insulated drain pans of welded steel finished with rust-inhibiting primer and finish coat. Pans shall extend under coils, valves and pipe connection assembly within unit casing.

15-33.3.2.7 Casing.- Furnish minimum 18 gage galvanized steel insulated cabinets that are factory corrosion-resistant treated and finished with a baked-on enamel finish. Line cabinets with rigid fiberglass insulation of minimum 3/4 inch thickness having an exposed surface resistant to spalling, flaking and deterioration of insulation material. Provide casing with the filter frame, manufacturer required knockouts for piping and electrical connections and those as indicated on the drawings. Unit casing shall be designed with removable covers to all accessible and maintainable components.

15-33.3.3 Outdoor condensing unit section.-

15-33.3.3.2 Condenser coils.- Provide nonferrous seamless (copper) tubes with mechanically bonded aluminum fins. Spine (hair) fins shall not be accepted. Coils shall be physically protected against hail and mechanical damage to the fins via coil guards.

15-33.3.3.3 Fans and motors.- Provide propeller type fan with direct drive or belt drive for vertical discharge. Provide motors which are inherently protected, permanently lubricated, and weatherproof.

15-33.3.3.4 Casing.- Furnish a unit designed for outdoor mounting. Fabricate the casing of heavy gage galvanized steel and finished with baked-on enamel. Provide removable access panels to controls compartments.

15-33.3.3.5 Controls.- Provide safety and operating controls factory wired and mounted in a separate enclosure. Control voltage to be 120 volts or less. Include high and low pressure switches and compressor motor overload

devices. Furnish a time delay device to prevent short cycling. Employ a control transformer, a pressure relief device and suction and discharge valves with service connections.

15-33.3.6 Temperature controls.- Furnish units with remote wall mountable multi-setback type programmable thermostats suitable for this application. Thermostats shall be compatible for controlling unit provided and shall be coupled with a control transformer if required. Provide electromagnetic (RFI) shielding for all programmable thermostats. Known acceptable sources are; White-Rogers, American-Stabilis, Honeywell, Johnson-Controls, Harper-Wyman, or approved equal.

15-33.4 Installation.- Install equipment in accordance with the manufacturer's recommendations and as shown on the drawings. Ensure all minimum maintenance and code required clearances are complied with. Units shall be isolated from vibration between the mounting structure and connecting ductwork using spring or rubber-in-shear vibration isolation mounts and flexible canvas connectors, respectively.

15-33.5 Quality assurance.-

15-33.5.1 Submittals.-

- (a) Manufacturer's catalog data

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15-36 REFRIGERANT PIPING AND APPURTENANCES

15-36.1 General.-

15-36.1.1 Scope.- This section specifies the furnishing and installation of copper tubing, valves, strainers, and sight glass for refrigerant piping.

15-36.1.2 Related work in other sections.-

Section 15-4: Pipe, Pipe Fittings and Piping Specialties - General

Section 15-24: Air-Cooled Condensers

Section 15-33: Split-System Fan Coil Units

15-36.2 Applicable documents.- The following specifications and standards, of the issues currently in force, form a part of this section and are applicable as specified herein:

15-36.2.1 American Society of Mechanical Engineers (ASME).-

B31.5 Refrigeration Piping

15-36.2.2 American Society for Testing and Materials (ASTM).-

B 280 Seamless Copper Tub for Air Conditioning and Refrigeration and Field Service.

15-36.3 Materials.-

15-36.3.1 Pipe and fittings.- Furnish refrigerant piping of Type ACR, hard-drawn copper tubing with sweat-type, wrought copper fittings. Cast fittings are not permitted.

15-36.3.2 Service valves.- Provide angle or globe service valves, with sweat connections. Use packed-type valves with gasketed seal cap and back seat feature. Valves must be wrench operated. Furnish valves especially designed for refrigerant service, in conformance with the ARI code. Place service valves at the inlet and outlet of each compressor, on both sides of each strainer and solenoid valve, and as otherwise shown and specified.

15-36.3.3 Solenoid valves.- Furnish pilot-operated, floating-piston solenoid valves suitable for operation with refrigerant, having a stainless steel stem and plunger assembly, and a stainless steel piston. Furnish solenoid coils which are sealed and moisture proof, operating on electrical characteristics of 115 volt, 60 Hertz.

15-36.3.4 Sight glasses.- Provide suitable double-window sight glass in the liquid line leaving the condenser or receiver.

15-36.3.5 Strainers.- Furnish Y-pattern or angle type strainers especially designed for operation with refrigerant specified. Strainers shall be constructed to permit the removal of the filter element without removing the strainer from the line.

15-36.3.6 Insulation.- Insulate all refrigerant suction and liquid line piping on air conditioning cooling type DX equipment.

15-36.3.7 Precharged factory-furnished piping.- In lieu of providing field/cut, cleaned, evacuated and charged copper piping for pipe sizes of less than or equal to 4-1/8-inches diameter (tubing), Contractor shall have the option of providing bright-annealed, air-conditioning and refrigeration (ACR-labeled) seamless copper tubing conforming to ASTM B 280. Coiled lengths shall be permitted up to 50 lineal feet for 1-5/8-inch diameter

coils. Tubing straight lengths shall be a standard 20 lineal feet. Piping shall be factory-dehydrated and factory-sealed with quick-connect couplers and charged with refrigerant R-407C.

15-36.4 Installation.

15-36.4.1 General.- Install refrigerant lines properly pitched with oil traps properly sized, located and installed. Any oil in any part of the system shall be able to find its way back to the compressor with the system operating on minimum capacity.

Field erected, evacuated and charged piping:

- (a) The Contractor shall utilize the services of a qualified refrigeration mechanic for the installation and testing of refrigerant piping and refrigeration equipment. Use of refrigerant clamping is required for all piping.
- (b) All refrigeration piping, installation and testing shall conform to the applicable requirements of ASME B31.5.
- (c) All pipe shall be cut with an acceptable type of pipe cutter, and reamed before brazing. Pipe shall pitch sharply toward the reamer during reaming and all cuttings shall be carefully removed after reaming. All moisture and dirt shall be removed from piping before joining as follows:
 - 1. A clean, lint less cloth shall be drawn through the tubing by means of wire or an electrician's tape, to remove all coarse particles of dirt and dust.
 - 2. A clean, lint less cloth saturated with trichloroethylene shall be pulled through pipe, until the saturated cloth is not discolored by dirt.
 - 3. A clean cloth saturated with compressor oil, squeezed dry, shall be drawn through the tubing. A visual inspection shall be made to see that tubing is perfectly clean.
 - 4. The cleaning shall be completed by pulling through a clean, dry, lint less cloth.
- (d) All joints shall be brazed. Valves and accessories shall be protected against excessive temperature during brazing.
- (e) **All piping piping shall be mounted using stainless steel material with stainless fastners.**

15-36.4.2 Evacuation and drying.- After refrigerant system has been pressure-tested, connect a suitable vacuum pump, and evacuate piping system, including all lines and equipment.

- (a) Open all isolating valves except those isolating equipment shipped from the factory with refrigerant holding or operating charge. Fill the system with dry nitrogen or "bone dry CO₂" to the test pressures specified in ASME B31.5 and make soap bubble tests at all joints. Carefully repair all leaks.
- (b) Exhaust system to rough vacuum and refill to not less than 50 psig (345 kPa) of refrigerant gas at an ambient temperature of not less than 60°F. (16°C.). Test entire system with a halide leak detector and carefully repair all leaks.
- (c) Evacuate system with a two-stage vacuum pump in first class condition to an absolute pressure not higher than 0.02 mm of mercury valve off pump, and hold for 12 hours minimum. If there is any loss of vacuum

readable on a vacuum gage, repeat pressurization test at 125 psig or 150 percent of operating pressure, whichever is greater.

- (d) Alternatively, a single stage vacuum pump in first class condition may be used, evacuating to 0.10 mm of mercury minimum. Hold vacuum one hour, break vacuum with refrigerant gas to 1-5 psig (7-34 kPa) positive pressure, and re-evacuate to 0.10 mm mercury minimum. Hold one hour, break, and evacuate a third time to 0.10 mm.
- (e) Open valves to isolate precharged equipment and charge the system. Make final check of all piping and equipment with a halide leak detector.
- (f) Operate the system for the equivalent of eight hours at full load, with refrigerant passing through the driers. Check oil levels frequently during this period and add oil whenever required. Use only refrigerant oil in sealed cans furnished by the compressor manufacturer.
- (g) The Contractor shall certify the system as ready for normal use.
- (h) The Contracting Officer's Representative shall be notified well in advance of the above testing procedures and shall witness the entire testing, evacuation and charging operation to see that it fully complies with the procedures recommended by the manufacturer. The Contractor shall not perform these operations unless the Contracting Officer's Representative is present.

15-36.4.3 Precharged piping.- Where ACR annealed copper tubing having "quick-connect" couplings to match equipment connections is factory-furnished in precharged lengths, the foregoing cleaning, drying and evacuation procedures do not apply. Should precharged piping loose its charge as a result of a piping or system leak prior to installation and/or commissioning of the equipment it services, Contractor shall either replace the piping in question or evacuate, dry and recharge the system as applies at no additional cost to the Owner.

Install precharged piping with short radius bends as required for a neat and workmanlike installation. When making short radius bends, strip insulation from affected area and use only a lever-type hand bender properly sized for the tube size to be bent. Replace all piping that collapses or buckles during installation. Replace insulation and properly fasten to piping at all bends, tees and connections.

15-36.5 Quality assurance.-

15-36.5.1 Submittals.-

- (a) Manufacturer's catalog data

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DIVISION 16
ELECTRICAL
16-ELECTRICAL GENERAL PROVISIONS

16-1.1 General.-

16-1.1.1 Scope.- This project shall include the installation of two Liebert 30 ton DX air handlers with their separate condenser units and their associated wiring for both power and digital control. The contractor shall provide a new ground system attached to all the equipment which shall be cad welded to the existing counterpoise.

16-1.1.2 Code requirements and permits.- Perform work to meet or exceed the requirements of the NFPA 70 and other applicable statutes, ordinances, codes and regulations of governmental authorities having jurisdiction. Resolve any code violation discovered in Contract Documents with the COTR prior to award of contract. After award of the contract, make any corrections or additions necessary for compliance with applicable codes at no additional cost to the FAA. Obtain and pay for all permits and inspections.

16-1.1.3 Contract drawings.- Contract Drawings are diagrammatic only, and do not give fully dimensioned locations of various elements of work. Determine exact locations from field measurements.

16-1.1.4 Project record documents.- Maintain at the job site a separate set of white prints of the Contract Drawings for the sole purpose of recording the "as-built" changes and diagrams of those portions of work in which actual construction is significantly at variance with the Contract Drawings. Upon completion of the project, submit all materials to the Contracting Officer's Technical Representative(COTR), after verifying all the above data is shown correct.

16-1.1.5 General.- The rules, regulations and reference specifications enumerated herein shall be considered as minimum requirements and shall not relieve the Contractor from furnishing and installing higher grades of materials and workmanship than are specified herein or when so required by the Contract Drawings.

16-1.1.6 Workmanship.- All materials and equipment shall be installed in accordance with the Contract Drawings and the recommendations of the manufacturer as approved by the COTR. The installation shall be accomplished by skilled workman regularly engaged in this type of work.

16-1.1.7 Contract drawings.- Where the electrical drawings indicate (diagrammatically or otherwise) the work intended and the functions to be performed, even though some minor details are not shown, the Contractor shall furnish all equipment, material and labor to complete the installation work, and accomplish all the indicated functions of the electrical installation.

16-1.1.8 Concealed work.- Where the word "concealed" is used in connection with conduit, ducts, and cable trays, the word is understood to mean hidden from sight as in chases, furred spaces or above suspended ceilings. "Exposed" is understood to mean open to view unless indicated otherwise, all conduits shall be concealed in finished areas and exposed in mechanical and electrical areas.

16-1.1.9 Protection.- Adequately protect against any damage work in progress, equipment, fixtures, and materials. At work completion, all work must be clean and in good condition.

16-1.1.10 Lay out and coordinate all work well enough in advance to avoid conflicts or interference's with other work in progress so that in case of interference the electrical layout may be altered to suit the conditions, prior to the installation of any work and without additional cost to the FAA.

16-1.2 Applicable documents.- The following specifications and standards of the issues currently in force, form a part of this section, and are applicable as specified herein:

16-1.2.1 National Fire Protection Association (NFPA).-

70 National Electrical Code (NEC)

16-1.2.2 Additional requirements.-

16-1.2.3 Conflicts in applicable documents.- If conflicts occur between FAA documents and any other document, FAA requirements shall be used. If conflicts occur between other documents, the more stringent requirement shall be used.

16-1.3 Materials.-

16-1.3.1 Material and equipment shall conform to respective publications and other requirements specified below. Materials to be furnished by the Contractor under this specification shall be of manufacturers regularly engaged in the production of such materials and of the manufacturer's latest designs that comply with the specification requirements.

16-1.3.2 Galvanizing.- All structural and miscellaneous steel used in connection with electrical work and located out-of-doors or in damp locations shall be hot-dip galvanized unless otherwise specified.

16-1.4 Special considerations.-

16-1.4.1 Seal equipment or components exposed to the weather and make watertight and insect proof. Protect equipment outlets and conduit openings with temporary plugs or caps at all times that work is not in progress.

16-1.4.2 Identification of equipment.- Attach an engraved nameplate to each piece of equipment including disconnect switches and motor starters. Clearly identify on the engraved nameplate the equipment served and spell out the full name of the equipment such as "Air Handling Unit AH-1" and "Hot Water Cir. Pump P-1" in lieu of abbreviated plan references such as "AH-1" or "P-1." Nameplate shall include voltage and phase.

16-1.4.3 Preparation of surfaces.-

16-1.4.3.1 Rust prevention.- Provide hot dip galvanized components for ferrous materials exposed to the weather.

16-1.5 Quality assurance.-

16-1.5.1 Guarantee.- Guarantee work for one year from the date of final acceptance of the project and during that period make good on any faults or imperfections that may arise due to defects or omissions in materials or workmanship.

16-1.5.2 Tests.- Provide the tests as outlined hereinafter and other tests necessary to establish the adequacy, quality, safety, completed status and suitable operation of each system. Tests are to be conducted in the presence of the Contracting Officer's Representative.

16-1.5.2.1 Operating test.- After the wiring system installation is completed, and at such time as the COTR may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the COTR or an authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, and the FAA will furnish the necessary electric power.

16-2.1 General.- Raceways

16-2.1.1 Scope.- This section specifies the furnishing and installation of electrical raceway systems.

16-2.1.2 Related work in other sections.- Not Used.

16-2.2 Applicable documents.- The following specifications and standards of the issues currently in force, form a part of this section, and are applicable as specified herein:

16-2.2.1 American Society for Testing and Materials (ASTM).-

A 123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

16-2.2.2 National Fire Protection Association (NFPA) Publications.-

70 National Electrical Code

16-2.2.3 Additional requirements.- For additional requirements, refer to Section 16-1 ELECTRICAL GENERAL PROVISIONS.

16-2.3 Materials.-

16-2.3.1 Conduit and fittings.- no comment

16-2.3.1.1 Rigid steel conduits (RGS).- no comment

16-2.3.1.1.1 Exposed outdoor or underground conduits.- Exposed outdoor or underground conduits shall be rigid zinc-coated steel.

16-2.3.1.1.2 Fittings.- Threaded, malleable iron, either cadmium plated or hot dipped galvanized.

16-2.3.1.2 Electrical Metallic Tubing (EMT).-

16-2.3.1.2.1 Material.- Galvanized electrical steel tubing.

16-2.3.1.2.2 Fittings.- Fittings shall be compression type, malleable iron, either cadmium plated or hot-dipped galvanized.

16-2.3.1.3 Flexible conduits.- Flexible conduits shall conform to Federal Specifications WW-C-566. Flexible conduits of 12 inch minimum length shall be used for connections to motors, and to equipment subject to vibration or movement unless otherwise shown. Liquid-tight flexible conduits shall be used in wet locations.

16-2.3.1.4 Size of conduits.- Size of conduits shall be as indicated on the Drawings. Where not indicated, the conduits shall be sized in accordance with the requirements of the NFPA 70. Minimum size of conduits shall be 3/4-inch.

16-2.3.1.5 Changes in direction.- Changes in direction or runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed. Care shall be taken to prevent the lodgment of plaster, dirt, or trash in raceways, boxes, fittings and equipment during the course of construction. Clogged raceways shall be entirely freed of obstructions or shall be replaced.

16-2.4 Installation.-

16-2.4.1 All items shall be installed in accordance with the NFPA 70 or to any more restrictive requirement of this specification.

16-2.4.1.1 Types according to location or use.-

- (a) Exposed in open work areas, mechanical rooms, or electrical rooms.- EMT.
- (b) Concealed in exterior walls.- EMT.
- (c) Concealed in interior walls or ceiling spaces or air conditioned areas.- EMT.
- (d) Exterior-exposed or concealed in exterior construction.- RGS.

16-2.4.2 Metallic conduits must be mechanically and electrically continuous between enclosures such as outlet, junction and pull boxes, panels, cabinets, etc. The conduit must enter and be secured to enclosures so that each system is electrically continuous throughout. Where knockouts are used, provide double locknuts, one on each side, and bonding jumpers around concentric knockouts where used. At conduit terminations, provide insulated bushings for conductor protection. Where conduits terminate in equipment having a ground bus, such as in switch gear and panel boards, provide conduit with an insulated grounding bushing and ground wire connected to the ground bus.

16-2.4.2.1 Run concealed or exposed conduit parallel or at right angles to building or other construction lines in a neat and orderly manner. Conceal conduit in finished areas. Run conduit below the ceiling as directed and with largest radius bends as possible.

16-2.4.2.3 Threads.- Clean all threads of rigid conduit. Coat all male threads of conduit installed in concrete with sealing compound to enhance electrical contact and provide water-proof joint or connection immediately before being coupled together. T and B "KOPR-SHIELD" is an approved sealing compound.

16-2.4.2.4 Running threads.- Running threads will not be allowed.

16-2.4.2.5 Electrical equipment located in the air conditioned spaces and subject to vibration and movement excluding motors: flexible metal conduit, 24 inches or 10 diameters minimum length.

16-2.4.2.6 Electrical equipment subject to vibration and movement, and all motors: liquid-tight flexible metal conduit, 24 inches or 10- conduit diameter minimum length.

16-2.4.3 Installation methods.-

16-2.4.3.1 Install each entire conduit system complete before pulling in any conductors; clean the interior of every run of conduit before pulling in conductors to guard against obstructions and omissions.

16-2.4.3.2 Cut all joints square, then thread and ream smooth. Coat cuts, threads or scratches on steel conduit with an approved zinc chromate or with a 90-percent zinc paint. When dry, draw up tight.

16-2.4.3.3 Make bends with standard ells or conduit bent to not less than same radius. Bends must be free from dents or flattening. Use no more than the equivalent of three 90-degree bends in any run between terminals and cabinets, or between outlets and junction boxes or pull boxes.

16-2.4.3.4 Raceways in furred spaces.- Install raceways in accordance with code requirements. Do not anchor or strap conduits to the ceiling furring channels or attach to furred ceiling hanger wires. Raceways shall not be attached to the suspension system (wire hangers) of drop ceilings.

16-2.4.3.5 Securely fasten and support exposed conduit to metal framing using Stainless Steel, one-hole pipe straps or other approved means.

16-2.4.3.6 Bushings and locknuts.- Every conduit termination, whether into a box or a free end, shall have a plastic insulating bushing installed including where grounding bushings are required. Where GRS conduits terminate into boxes, they shall be fastened with double locknuts (inside and outside of box) and bushings. Where EMT conduits terminate into boxes, they shall be fastened with one locknut, compression box connector fitting, and insulated bushing.

16-2.4.3.7 Outlet boxes and pull boxes.-

16-2.4.3.7.1 Rigidly mount all boxes and provide with suitable screw fastened covers. Plug open knock-outs or holes in boxes with suitable blanking devices.

16-2.4.3.7.2 Install pull boxes in locations that will be accessible after completion of the project.

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16-3 INSULATED CONDUCTORS

16-3.1 General.-

16-3.1.1 Scope.- This section specifies the furnishing and installation of insulated conductors. Sizes indicated on Drawings shall be the minimum size acceptable conductors.

16-3.2 Applicable documents.- The following specifications and standards of the issues currently in force, form a part of this section, and are applicable as specified herein:

16-3.2.2 National Electrical Manufacturers' Association (NEMA) Standards.-

WC-5	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
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16-3.2.3 National Fire Protection Association (NFPA) Publications.-

No. 70	National Electrical Code
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16-3.2.4 Additional requirements.- For additional requirements, refer to Section 16-1 ELECTRICAL GENERAL PROVISIONS.

16-3.3 Materials.-

16-3.3.1 Color coding.- All branch circuit and feeder conductors shall be color coded as specified hereinafter. The color coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable in any part of the installation. The equipment grounding conductor shall be covered with green insulation or shall be bare copper as specified herein. Conductors covered with green insulation with yellow tracers shall be used for other grounding systems. Neutral conductors shall be continuous white for 120/208-volt system. The neutral of the other systems shall be white with identifiable colored tracers (not green). Where color coding is not available in the larger size conductors, the conductors shall be color coded by use of color coded tape, half lapped for a minimum length of 3 inches. Where conductors are color coded in this manner, they shall be color coded in all junction and pull boxes accessible raceways, panel boards, outlets, and switches, as well as at all terminations. Conductors in accessible raceways shall be coded in such manner that by removing or opening any cover, the coding will be visible.

Phase conductors shall be color coded as follows:

Three Phase

120/208 Volts

Phase A - Black

Phase B - Red

Phase C - Blue

16-3.3.2 600-Volt conductors.-

16-3.3.2.1 Size.- Conductor size shall be as shown with minimum size of wire to be No. 12 AWG, unless otherwise specified or indicated.

16-3.3.2.2 Conductor.- Conductor shall be soft-drawn, annealed copper. Aluminum wire shall not be used.

16-3.3.2.3 Insulation (NEMA WC 5).- Unless otherwise indicated, insulated conductors shall be copper with thermoplastic or thermosetting insulation, type THW, THWN, and XHHW for general use. For underground feeders, type UF, XHHW-USE, RHW-USE.

16-3.3.2.4 Fixture wiring.- Fixture wiring shall be copper, with thermoplastic insulation type TF, TFF, TFN or TFFN insulated for 600 volts.

16-3.3.2.5 General wiring.- Conductors No. 10 AWG and smaller shall be solid, and conductors No. 8 AWG and larger shall be stranded. Minimum branch circuit conductor size shall be No. 12 AWG. Minimum control wire size shall be No. 14 AWG unless noted otherwise.

16-3.4 Installation.-

16-3.4.1 Install to ensure total compliance with NFPA 70.-

16-3.4.2 Protection.- Unless otherwise indicated, mechanically protect conductors for systems by installing in raceways. Do not install the conductor until raceway system is complete. Use an approved wire- pulling compound when pulling large conductors. Do not bend any conductor either permanently or temporarily during installation to radii less than eight times the outer diameter of 600-volt insulated conductors. Do not exceed manufacturer's recommended values for maximum pulling tension.

16-3.4.3 Splices and terminations.- Use tool installed compression connectors for terminations or splices of all stranded conductors. Use ring-tongue type terminators on all control wiring. Utilize preinsulated connectors for splices and taps in conductors No. 10 AWG and smaller. All other twist-on connectors must be reviewed by the COTR prior to installation. Also, utilize this type of connector for factory-made splices in fixtures or equipment.

Tape all splices and joints with vinyl plastic tape. Use sufficient tape to secure insulation strength equal to that of the conductors joined. Cover all splices in handholes or manholes with submersible, heat-shrink or tape insulation.

16-3.4.4 Appearance.- Neatly and securely bundle or cable all conductors in an enclosure using nylon straps with a locking hub or head on one end and a taper on the other.

16-3.4.5 Size.- Install conductor sizes as indicated. Provide No. 10 conductor for single-phase, 20-ampere circuits for which the distance from panel board to the first outlet is more than 100 feet.

16-3.4.6 Home runs.- Each branch circuit shall have its own neutral conductor and separate green insulated equipment grounding conductor. No common neutral shall be used. Use home run circuit numbers as indicated for panel board connections.

16-3.4.6.1 Conduit size.- Use 3/4-inch minimum.

16-3.4.7 Conductor support.- Provide conductor supports as required by the code and recommended by the cable manufacturer.

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16-4 BOXES

16-4.1 General.-

16-4.1.1 Scope.- This section specifies the furnishing and installation of outlet boxes, junction boxes and pull boxes.

16-4.2 Applicable documents.- The following specifications and standards of the issues currently in force, form a part of this section, and are applicable as specified herein:

16-4.2.1 National Fire Protection Association (NFPA) Publications.-

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National Electrical Code

16-4.2.2 Additional provisions.- For additional provisions, refer to Section 16-1 ELECTRICAL GENERAL PROVISIONS.

16-4.3 Materials.-

16-4.3.1 Outlet Boxes.-

16-4.3.1.1 Flush device boxes.- Provide galvanized steel boxes of sufficient size to accommodate wiring devices to be installed at outlet. Provide an extension ring for the device to be installed. Square or rectangular boxes may be supplied. Unless otherwise noted, provide 2-1/8 inch deep by 4-inch square boxes.

16-4.3.1.2 Exposed device boxes.- Provide FS conduit boxes for surface mounting in areas having exposed conduit systems.

16-4.3.1.3 Boxes for lighting fixtures.- Provide galvanized steel octagonal boxes with fixture stud supports and attachments as required to properly support ceiling and bracket-type lighting fixtures. Unless otherwise noted, provide 4-inch boxes 2-1/8 inches deep.

16-4.3.1.4 Masonry boxes.- Provide galvanized steel, 3-1/2 inch deep, masonry boxes for all devices installed in masonry walls. Use boxes with 1-gang capacity in excess of the number of devices to be installed. Provide extension ring covers for the number of devices to be installed.

16-4.3.2 Junction, pull and splice boxes.-

16-4.3.2.1 Construction.- Provide Stainless steel boxes conforming to NEMA Standards.

16-4.3.2.2 Interior spaces.- Provide NEMA 1 type boxes at least 4 inches deep.

16-4.3.2.3 Exterior spaces.- Provide NEMA 3R type boxes at least 4 inches deep.

16-4.3.2.4 Embedded.- Provide NEMA 4 cast type with external recessed flanged cover when cast in concrete.

16-4.4 Installation.-

16-4.4.1 Outlet boxes.-

16-4.4.1.1 Flush boxes.- Unless otherwise indicated, mount all outlet boxes flush within 1/4 inch of the finished wall or ceiling line. Provide galvanized steel extension rings where required to extend the box forward in conformance to NFPA 70 requirements. Attach ring with at least two machine screws. Securely fasten outlet boxes in position using clips or other suitable means. Provide plaster covers for all boxes in plastered walls and ceilings.

16-4.4.1.2 Fixture boxes.- Where boxes for suspended lighting fixtures are attached to and supported from suspended ceilings, adequately distribute the load over the ceiling support members.

16-4.4.1.3 Mounting height.- Mounting height of a wall-mounted outlet box means the height from finished floor to horizontal center line of the cover plate. Where outlets are indicated adjacent to each other, mount these outlets in a symmetrical pattern with all tops at the same elevation. Where outlets are indicated adjacent, but with different mounting heights, line up outlets to form a symmetrical vertical pattern on the wall. Verify the final location of each outlet with Contracting Officer's Representative before rough-in. Remove and relocate any outlet box placed in an unsuitable position.

16-4.4.1.4 Back-to-back boxes.- Provide 12-inch separation between outlets on opposite sides of wall unless approval is obtained. Where such a connection is necessary to complete a particular installation, fill the voids around the wire between the boxes with sound insulating material.

16-4.4.1.5 Box openings.- Provide only the conduit openings necessary to accommodate the conduits at the individual location.

16-4.4.3 Junction and pull boxes.-

16-4.4.3.1 Installation.- Install boxes as required to facilitate cable installation in raceway systems. Generally provide boxes in conduit runs of more than 100 feet or with more than three 90-degree bends. Locate boxes strategically and make them of such shape to permit easy pulling of wire or cables.

16-4.4.3.2 Covers.- Provide boxes so that covers are readily accessible and easily removable after completion of the installation. Include suitable access doors for boxes above suspended ceilings.

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16-5 WIRING DEVICES

16-5.1 General.-

16-5.1.1 Scope.- This section specifies the furnishing and installation of wiring devices and device plates.

16-5.2 Applicable documents.-The following specifications and standards of the issues currently in force, form a part of this Section, and are applicable as specified herein.

16-5.2.1 National Fire Protection Association (NFPA) Publications.-

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National Electrical Code

16-5.3 Additional provisions.- For additional provisions, refer to Section 16-1 ELECTRICAL GENERAL PROVISIONS.

16-5.4 Materials.-

16-5.4.1 All devices shall be specification grade.

16-5.4.2 Wall switches.- Wall switches shall be of the totally enclosed tumbler type with bodies of phenolic compound. Handles shall be ivory. Wiring terminals shall be of the screw type. Not more than one switch shall be installed in a single-gang position. The switches shall be for use on alternating current only.

16-5.4.2.1 Rating.- 20 amperes, 120/240 volts.

16-5.4.3 Receptacles.-

16-5.4.3.1 Single and duplex receptacles.- Single and duplex receptacles shall be two-pole, three-wire grounding type, with polarized parallel slots. The receptacles shall be rated as shown on the Drawings. Bodies shall be of ivory phenolic compound supported by mounting strap having plaster ears. Contact arrangement shall be such that contact is made on two sides of an inserted blade. Receptacle shall be side- or back-wired with two screws per terminal. The third grounding pole shall be connected to the metal mounting yoke.

16-5.4.3.1.1 Ground Fault Interrupting (GFI) receptacles.- GFI receptacles shall be installed in all locations required by NFPA 70 and other locations as indicated in the drawings. All exterior GFI receptacles shall be with weatherproof cast outlet box and cover.

16-5.4.3.1.1 Weatherproof receptacles.-Weatherproof receptacles shall consist of a receptacle as specified in paragraph: SINGLE AND DUPLEX RECEPTACLES, mounted in a box with a gasketed, weatherproof, cast-metal cover plate and cap over each receptacle opening. The cap shall be provided with a spring-hinged flap.

16-5.4.3.2 Wall and device plates.- Plates for each switch, receptacle, or outlet shall be of 302 stainless steel. Plates shall be of the one piece type and shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster filling will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional-type device plates will not be permitted. Plates installed in wet locations shall be gasketed. Plates for surface mounted outlet boxes shall be galvanized steel, raised type.

16-5.4.4 Installation.-

16-5.4.4.1 Device coordination.- Where items of equipment are provided under other sections of this specification or by the FAA, provide a compatible receptacle for the cap or plug and cord of the equipment.

16-5.4.4.2 Wall switches.-

16-5.4.4.2.1 Location.- Set wall switches in a suitable steel outlet box centered at the height of 48 inches from the floor, except as otherwise shown. Install switch on the strike side of the door as finally hung.

16-5.4.4.2.2 Position.- Install wall switches in a uniform position so the same direction of operation will open and close the circuits throughout the job, generally up or to the left for the ON position.

16-5.4.4.3 Receptacles.- Mount receptacles vertically in a suitable steel outlet box centered at the height of 15 inches from the floor or as shown on the Drawings. The Contracting Officer reserves the right to make any reasonable changes in receptacle locations without change in the Contract amount.

16-5.4.4.4 Device plates.-

16-5.4.4.4.1 Required.- Provide device plates for each outlet box of the type required for service and device involved.

16-5.4.4.4.2 Ganged devices.- Mount ganged devices under a single, one- piece, device plate.

16-5.4.4.4.3 Engraving.- Engrave plates with 1/8 inch high black letters, if designated for engraving.

16-5.4.4.5 Grounding.- Ground all receptacles to the enclosing metal box by connecting the device ground terminal to the box with #10 bare copper wire.

Note: All outside disconnect switches shall be Stainless Steel Heavy Duty, all interior disconnect boxes shall be heavy duty. All exterior supports shall be stainless steel including anchors. Contractor shall follow all FAA orders and standards for electrical and grounding.

FAA-C-1217f
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SUPERSEDING
FAA-C-1217e, 01/25/91

Appendix A

US DEPARTMENT
OF TRANSPORTATION
**Federal Aviation
Administration**

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ELECTRICAL WORK, INTERIOR

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FORWARD

This document has been revised to reflect current technology changes and to incorporate the latest commercial standards.

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1. SCOPE

1.1 Scope

This specification covers the *minimum requirements* for electrical work at FAA facilities.

Where the phrase "unless otherwise indicated" or similar wording appears, it refers exclusively to other documents that are specific parts of the contract. Where there are requirements peculiar to specific FAA facility types, e.g., air route traffic control centers (ARTCCs), metroplex control facilities (MCFs), terminal radar control (TRACONs), etc., these requirements will be added following the appropriate paragraph.

2. APPLICABLE DOCUMENTS

The current issues of the following documents in effect on the date of the invitation-for-bids or request-for-proposals form a part of this specification, and are applicable to the extent specified herein.

2.1 Federal specifications

J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)
W-C-375	Circuit Breakers, Molded Case; Branch Circuit and Service
W-F-414	Fixture, Lighting (Fluorescent, Alternating Current, Pedant Mounting)
W-L-305	Light Set, General Illumination (Emergency or Auxiliary)
W-P-115	Panel, Power Distribution
WW-C-566	Conduit, Metal, Flexible
QQ-W-343	Wire, Electrical, (uninsulated)

(To obtain copies of federal specifications, contact General Services Administration offices in Washington DC, Atlanta, Boston, Chicago, Dallas, Denver, Kansas City MO, Los Angeles, New York, San Francisco, or Seattle.)

2.2 Steel Structures Painting Council standards

SSPC-PS 10.01 Hot-Applied Coal Tar Enamel Painting System

(Single copies of SSPC Standards can be obtained from the Steel Structures Painting Council, 4400 Fifth Avenue, Pittsburgh, Pa 15213, 412/578-3327)

2.3 Federal Aviation Administration specification/standards/orders

FAA specification:

FAA-C-1391	Installation and Splicing of Underground Cables
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FAA standards:

FAA-STD-019	Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities
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FAA-STD-020	Transient Protection, Grounding, Bonding and Shielding Requirements for Electronic Equipment
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FAA orders:

3900.49	Control of Hazardous Energy During Maintenance, Servicing and Repair
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6950.19	Practices and Procedures for Lightning Protection, Grounding, Bonding and Shielding Implementation
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6950.20	Fundamental Consideration of Lightning, Protection, Grounding, Bonding and Shielding
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6950.22	Maintenance of Electrical Power and Control Cables
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6950.27	Short Circuit Analysis and Protective Device Coordination Study
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(Copies of FAA specifications may be obtained from the Contracting Officer in the office issuing the invitation-for-bids or request-for-proposals. Requests should fully identify material desired, i.e., specifications, standard, amendment, and drawing numbers and dates. Requests should cite the invitation-for-bids, request-for-proposals, or the contract involved or other use to be made of the requested material.)

2.4 National Fire Protection Association (NFPA) publications

NFPA 70	National Electrical Code (NEC)
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(Requests for copies of NFPA publications should be addressed to the National Fire Protection Association, Batterymarch Park, Quincy MA 02269.)

2.5 National Electrical Manufacturers Association (NEMA) standards

OS-1	Sheet Steel Outlet Boxes, Device Boxes, covers and Box Supports
MG-1	Standard for Motors and Generators
ST 20	Dry Type Transformers for General Applications
VE 1	Cable Tray Systems
WC 5	Thermoplastic Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
WD 1	General Requirements for Wiring Devices

(For copies of NEMA standards, contact the National Electrical Manufacturers Association, 2101 L Street N.W. Washington DC 20057, 202/457-8400.)

2.6 Underwriters' Laboratories (UL) Inc. standards

UL 5	Surface Metal Raceways and Fittings
UL 6	Rigid Metal Conduit
UL 50	Enclosures for Electrical Equipment
UL 486A	Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486C	Splicing Wire Connectors
UL 486E	Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors
UL 514A	Metallic Outlet Boxes
UL 514B	Fittings for Conduit and Outlet Boxes
UL 542	Lampholders, Starters, and Starter Holders for Fluorescent Lamps
UL 651	Schedule 40 and 80 Rigid PVC

UL 797	Electrical Metallic Tubing
UL 870	Wireways, Auxiliary Gutters and Associated Fittings
UL 935	Fluorescent-Lamp Ballasts
UL 1242	Intermediate Metal Conduit

(For copies of UL standards, contact Underwriters' Laboratories Inc., Publication Department, 333 Pfingsten Rd., Northbrook IL 60062.)

2.7 Institute of Electrical and Electronics Engineers (IEEE) Inc. standards

STD C57.12.80	Standard Terminology for Power and Distribution Transformers
STD 141	Recommended Practice for Electric Power Distribution for Industrial Plants
STD 519	Recommended Practices and Requirements for Harmonic Control and Electrical Power Systems
STD 1100	Recommended Practice for Powering and Grounding Sensitive Electronic Equipment

(For copies of this standard, contact the IEEE Inc., Service Department, 445 Hoes Lane, PO Box 1331, Piscataway, NJ 08855-1331.)

2.8 Other documents

2.8.1 Local utility companies

The rules and regulations of the local utility companies providing service.

2.8.2 Local governing bodies

The rules, regulations, and codes of local governing bodies.

3. MATERIALS

3.1 General

The contractor shall furnish all materials not specifically identified as Government Furnished Materials in the invitation-for-bids or contract. Materials and equipment shall comply with all requirements of the contract documents. Materials furnished by the contractor shall be new, the standard products of manufacturers regularly engaged in the production of such materials, and of

the manufacturer's latest designs that comply with the specification requirements. If materials and equipment requirements conflict, the order of precedence for selection shall be as follows: special contract provision, the contract drawings, this specification, and then continuing order of precedence, referenced FAA documents, Military documents, Federal specifications, NFPA publications, IEEE standards; UL standards and NEMA standards. Wherever standards have been established by Underwriters' Laboratories, Inc., the material shall bear the UL label.

4. INSTALLATION

NOTE: Unscheduled interruptions of the electrical service to FAA facilities may cause aircraft accidents and loss of life. Work requiring a temporary or permanent deenergization of equipment shall be scheduled in writing with the onsite FAA maintenance personnel. Only onsite FAA maintenance personnel are authorized to energize, deenergize equipment or to operate a circuit breaker, switch, or fuse in an FAA facility. Work procedures shall include lock-out/tag-out procedures in accordance with FAA Order 3900.49.

4.1 General

The rules, regulations and reference specifications enumerated herein shall be considered as minimum requirements. FAA requirements often exceed those of other standards organizations such as the NEC. Adherence to other standards shall not relieve the contractor from furnishing and installing higher grades of materials and workmanship when so required by this specification. Adherence to this specification shall not relieve the contractor from furnishing and installing higher grades of materials and workmanship when so required by the contract drawings or special contract provisions. This specification shall govern when conflicts occur between it and the documents referenced in paragraph 2, Applicable documents, and in the order of precedence established in paragraph 3, Materials.

4.1.1 Short circuit analysis and protective device coordination (SCA/PDC)

The distribution system and all component parts, when installed or as modified, shall be in accordance with IEEE Standard 519, Recommended Practices and Requirements for Harmonic Control and Electrical Systems, and shall include a short circuit analysis and protective device coordination study in accordance with FAA Order 6950.27.

4.2 Workmanship

All materials and equipment shall be installed in accordance with the contract drawings. When manufacturers recommended installation methods conflict with contract requirements, differences shall be resolved by the Contracting Officer. The installation shall be accomplished by qualified workers regularly engaged in this type of work. Where required by local regulations, the workers shall be properly licensed.

4.3 Contract drawings

Where the electrical drawings indicate (by diagram or otherwise) the work intended and the functions to be performed, even though some details are not shown, the contractor shall furnish all equipment, material (other than the Government-furnished items, see paragraph 3.1) and labor to complete the installation work and to accomplish all the indicated functions of the electrical

installation. Further, the contractor shall be responsible for taking the necessary actions to ensure that all electrical work is coordinated and compatible with architectural, mechanical, and structural plans, and the layout of any special electronic equipment.

4.3.1 Minor departures

Minor departures from exact dimensions shown on the electrical plans may be permitted when required to avoid conflict or unnecessary difficulty in placement of a dimensioned item, provided all contract requirements are met. The contractor shall promptly obtain approval from the Contracting Officer prior to undertaking any such departure and shall provide appropriate documentation of the departure.

4.4 Grounding

4.4.1 General

FAA grounding requirements often exceed those of the NEC. Grounding systems shall be as indicated on the contract drawings and as specified herein. Reference IEEE Standard 1100-1992, Recommended Practice for Powering and Grounding Sensitive Electronic Equipment, when installing all NAS equipment. In no case, however, shall the NEC be violated.

4.4.2 Grounding electrode conductor

The grounding electrode conductor shall be bare or insulated copper and shall be sized as shown in the contract documents. When not indicated in the contract documents, the conductor shall be copper and sized in accordance with Table 250-94, "Grounding Electrode Conductor for AC Systems", of the NEC, except that the conductor shall not be smaller than No. 6 AWG. Where the grounding electrode conductor is routed through a metal raceway, the raceway shall be electrically continuous and bonded to the conductor at each end. The grounding electrode conductor shall be bonded to the earth electrode system with an exothermic welded joint. For a separately derived system such as an isolation transformer, the grounding electrode conductor shall be connected in accordance with the NEC. This conductor shall be permitted to terminate by exothermic welding to an equipment room's perimeter ground cable under a raised floor.

4.4.3 Earth electrode system

The earth electrode system shall be installed as shown in the contract documents. Unless otherwise indicated in these documents, the earth electrode system shall consist of a minimum of four (4) ground rods located at the corners of a structure. Rods shall be spaced apart a distance equal to or greater than the length of the rods. Ground rods shall be 3/4 inch by 10 feet, copper or copper-clad steel. Sectionalized type or exothermic butt welded rods shall be used when deeper earth penetration is required. Rods shall be interconnected by a bare copper cable forming a closed loop around a structure. The cable shall be a minimum No. 4/0 AWG and shall be buried at least 2 feet below grade. The top of the vertically-driven ground rods shall be a minimum of 12 inches below grade. All underground metal pipes (excluding gas piping systems), tanks, and the telephone ground, if present, shall be connected to the earth electrode system by a copper cable no smaller than No. 2 AWG. All underground connections shall be made by exothermic welding process unless otherwise indicated.

4.4.4 Earth electrode system resistance

The resistance of the earth electrode system shall not exceed 10 ohms, as tested per paragraph 5.3.6, unless otherwise indicated. If the measured resistance exceeds 10 ohms, the Contracting Officer shall be notified immediately for further guidance.

4.4.5 Equipment grounding conductor

4.4.5.1 General

All metallic non-current carrying parts of electrical equipment shall be grounded with equipment grounding conductors whether or not shown on the drawings. Equipment grounding conductors shall always be green insulated copper conductors unless otherwise indicated. Non-insulated equipment grounding conductors are not allowed. When these conductors are not sized, or shown on the contract drawings, they shall be sized in accordance with Table 250-122, "Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment", of the NEC.

4.4.5.2 Connections

There shall be no interconnection between equipment grounding conductors and neutral conductors except at the main service and separately derived sources. All connections to equipment to be grounded shall be made with a grounding connector specifically intended for that purpose. Bare wire, wrapped around mounting bolts and screws, is not acceptable as a grounding connection. All ground lugs shall be of a noncorrosive material suitable for use as a grounding connection, and must be compatible with the type of metal being grounded. All mating surfaces and connections shall be between cleaned bare metal to bare metal surfaces.

4.4.5.3 Installation

Each overcurrent device shall have its own equipment grounding conductor, i.e., a single-pole single-phase overcurrent device shall be supplied with an equipment grounding conductor; a two -pole, single-phase overcurrent device shall be supplied with its own equipment grounding conductor; a three-pole, three-phase overcurrent device shall be supplied with its own equipment grounding conductor. The equipment grounding conductor shall be installed in the same conduit as its related branch and feeder conductors and shall be connected to the ground bus in the branch or distribution panelboard. Metal conduit housing the equipment grounding conductor shall be electrically continuous, forming a parallel path to the equipment grounding conductor, except as allowed by the NEC. Where parallel feeders are installed in more than one raceway, a full sized equipment grounding conductor shall be installed in each raceway.

4.4.6 Raceway grounding

Surface metal raceways, wireways, or cable rack systems shall be installed in a manner that assures electrical continuity. Insulated copper bonding jumpers shall be installed between adjacent raceway sections to assure proper bonding. Uninsulated conductors shall not be used. Unless otherwise indicated, the minimum size for these bonding jumpers shall be No. 6 AWG. Where aluminum raceways are used, the jumpers shall be bonded with approved connectors for

the dissimilar metals. All metallic raceway penetrations into a facility structure shall be bonded to the earth electrode system in accordance with FAA-STD-019.

4.4.7 Other grounding systems

Any additional grounding systems used for electronic equipment shall be connected directly to the exterior earth electrode system or the perimeter ground cable under a raised floor in an equipment room. Other grounding systems shall not be used in place of the equipment grounding conductor system. The conductor used for other grounding (i.e., NEC 250-74, exception #4) systems shall be color coded green with a yellow stripe for single point isolated signal ground, green with an orange stripe for multipoint signal ground, green with a red stripe for high energy ground, green with a violet stripe for isolated equipment grounding connections.

4.5 Electrical surge protection

4.5.1 General

All electrical surge protection systems shall be installed in accordance with FAA -STD-019.

4.5.2 Supply transformer

For utility owned transformers, protective devices shall be at the discretion of the utility. For FAA owned transformers, proper protection shall be provided on the primary side of the transformer.

4.5.3 Service entrance surge arrester

A fused surge arrester provided with disconnect capability shall be installed on the line, (supply-side) of the service as close as possible to the service terminals. Separate terminating lugs shall be provided for the surge arrester. This arrester shall be compatible with the service voltage, and shall be wired to avoid loops, sharp bends and kinks, and to minimize the number of bends. There shall be no interconnection between neutral and ground within the arrester. Arrester conductors shall be No. 4 AWG insulated copper or larger, unless a smaller size is recommended by the arrester manufacturer.

4.5.4 Transient suppression installations

Where transient suppression devices are installed in the electrical power distribution system they shall be installed in accordance with manufacturers instructions unless otherwise specified.

4.5.5 Land line/cable penetration installations

Suppression systems shall be provided for land line and cable penetration systems in accordance with FAA-STD-019. High energy grounding conductors shall be bonded directly to the earth electrode system or to the perimeter ground cable under raised floors in equipment rooms.

4.6 Wiring methods

4.6.1 General

All wiring shall consist of insulated copper conductors installed in metallic raceways, unless otherwise specified.

4.6.1.1 Conductor routing

Panelboards, surge arresters, disconnect switches, etc., shall not be used as raceway for conductor routing other than conductors that originate or terminate in these enclosures. Isolated ground conductors will be allowed to traverse these enclosures.

4.6.1.2 Conductor separation

Power conductors shall be routed separately from all other conductor types. This may be accomplished by routing power conductors and other conductors in separate raceways, or by a metallic divider between the power conductors and the other conductors in the same raceway.

4.6.2 Neutral conductor

Shared/common neutrals shall not be permitted, i.e., each overcurrent device shall have its' own separate neutral conductor. Neutral conductor sizes shall not be less than the respective feeder or phase conductor sizes.

4.6.3 Raceway systems

4.6.3.1 General

Each run shall be complete, and shall be fished and swabbed before conductors are installed. Ends of raceway systems not terminated in boxes or cabinets shall be capped. Exposed raceways shall be installed parallel to or at right angles with the lines of the structure. Crushed or deformed raceways shall not be installed. A pull wire shall be installed in all empty tubing and conduit systems in which wiring is to be installed by others. The pull wire shall be No. 14 AWG zinc-coated steel, or plastic with a minimum 200-pound tensile strength. Ten inches of slack shall be left at each end of the pull wire. Sections of raceways which pass through to damp, concealed, or underground locations shall be of a type allowed for such locations by NEC Article 300-5, and shall extend a minimum of 12 inches beyond the damp, concealed, or underground area. Where raceway has to be cut in the field, it shall be cut square and burrs and sharp edges removed. Where conduits penetrate walls or floors separating the building interior from the exterior, they shall be sealed to prevent moisture and rodent entry and to deter air transfer. In addition, where conduits penetrate walls separating individually controlled temperature or humidity controlled areas, they shall be sealed to prevent air circulation. Sealing methods and sealants shall be accordance with NEC Article 300-7. Openings around penetrations through fire-resistant-rated walls, partitions, floors, or ceilings shall be fire stopped using approved methods to maintain the fire resistance rating.

4.6.3.2 Conduit

Minimum conduit size shall be 3/4 inch unless otherwise specified. Conduit for telephone and signal systems shall be allowed to be 1/2 inch. Where threads have to be cut on conduit, the threads shall have the same effective length and shall have the same thread dimensions and taper as specified for factory cut threads on conduit.

NOTE:

For ARTCCs, MCFs, and Large TRACONS, rigid steel conduit (RSC) or intermediate metal conduit (IMC) shall be used for all distribution panel feeders, transformer feeders, motor control center feeders and distribution switchboards. Electrical metallic tubing (EMT) may be used for communication, lighting and branch circuits.

4.6.3.2.1 Zinc coated rigid steel conduit (RSC)

Zinc coated rigid steel conduit (RSC) shall conform to UL 6. RSC, may be used in all locations and shall be used for all underground service conductors. For installation below slab, on-grade, or underground, the conduit shall conform to Steel Structures Painting Council Standard, SSPC-PS 10.01, or shall be field wrapped with 0.01-inch thick pipe wrapping plastic tape applied with 50% overlap. Fittings used underground shall be protected by field wrapping as specified herein for conduit. All fittings used with rigid steel conduit shall be the threaded type, of the same material as the conduit. Where conduits enter enclosures without threaded hubs, double locknuts (one on each side of the enclosure wall) shall be used to securely bond the conduit to the enclosure. In addition, a bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation.

4.6.3.2.2 Intermediate metal conduit (IMC)

IMC shall be zinc coated steel, shall conform to UL Standard 1242, and shall bear the UL label. For installation below slab on grade or underground, the conduit shall conform to Steel Structures Painting Council Standard, SSPC-PS 10.01, or shall be field wrapped with 0.01-inch thick pipe wrapping plastic tape applied with 50% overlay. Fittings used underground shall be protected by field wrapping as specified herein for conduit. Where it is necessary to fabricate IMC bends in the field, the tooling required to fabricate those bends shall be specifically designed for IMC. All fittings shall be of the threaded type, of the same material as the conduit. Where conduits enter enclosures without threaded hubs, double locknuts (one on each side of the enclosure wall) shall be used to securely bond the conduit to the enclosure. In addition, a bushing shall be installed on the interior threaded end of the conduit to protect conductor insulation.

4.6.3.2.3 Electrical metallic tubing (EMT)

EMT shall conform to UL 797. EMT may be used only in dry interior locations, and where not subject to physical damage. EMT shall not be used on circuits above 600 volts nor in sizes greater than 34 inches in diameter. Fittings used with EMT shall be standard compression-type fittings designed for this type of EMT, unless otherwise indicated. Screw –type fittings are not acceptable. Where EMT enters enclosures without threaded hubs, an appropriate connector with threads and cast or machined (not sheet metal) locknut shall be used to securely bond the conduit to the enclosure. The connector body and locknut shall be installed so that firm contact is made on each side of the enclosure. In addition the connectors shall have an insulated -throat, smooth bell shaped end, or a bushing.

4.6.3.2.4 Rigid aluminum conduit

Aluminum raceways shall not be used for any installation.

4.6.3.2.5 Rigid nonmetallic conduit

Rigid nonmetallic conduit shall be heavywall PVC conforming to UL 651. Rigid nonmetallic conduit used to protect electrical power conductors may only be used underground, or in concrete, or as a vertical riser to 6 inches above grade or floor surface for connection to metal conduit; and only when required by the contract drawings or specific job specifications. PVC fittings shall be used with PVC conduit and shall be assembled in accordance with manufacturer's instructions. A PVC threaded fitting with locknut and plastic bushing shall be used to connect PVC conduit to boxes or cabinets without threaded hubs. Rigid nonmetallic conduit may be used to protect lightning protection system conductors and, in interior locations, to protect signal grounding conductors.

4.6.3.2.6 Flexible metal conduit

Flexible metal conduit shall conform to Federal Specification, WW-C-566. Flexible metal conduit shall be used for terminal connections to motors or motor driven equipment, and in lengths only up to 6 feet for other applications permitted by the NEC. Liquid-tight flexible metal conduit shall be used outdoors and in wet locations. All flexible metal conduit shall be of a type where both the conduit and fittings are listed for grounding. This last requirement shall not apply to factory assembled equipment.

NOTE: Flexible metal conduit may be used under raised floor for branch circuits in lengths longer than 6 feet in computer room locations that meet all the requirements of Article 645 of the NEC. All fittings and junction boxes shall be liquid tight types under the raised floor.

4.6.3.2.7 Flexible nonmetallic conduit

Flexible nonmetallic conduit shall not be used.

4.6.3.3 Surface raceways

Nonmetallic surface raceways shall not be used. Surface metal raceways shall conform to UL 5. Surface metal raceways shall be installed only in exposed, dry locations not subject to physical damage. Surface metal raceways shall meet NEC requirements, however, they shall not be used for circuits above 600 volts.

4.6.3.4 Wireways

Wireways shall conform to UL 870. Wireways shall only be installed in accessible locations. Wireways installed in wet or outdoor locations shall be rated for these locations.

4.6.3.5 Cable rack systems

4.6.3.5.1 General

Cable rack systems shall be of the ladder or ventilated trough type conforming to NEMA Standard VE 1, unless otherwise indicated. All components for each cable rack system shall be the product of a single manufacturer. Cable rack support spacing shall be as recommended by the manufacturer except that in no case shall spacing of supports exceed 6 feet. Cable racks shall be supported from structural members only.

4.6.3.5.2 Dimensions

Straight sections, bends, tees, offsets, reducers, etc., for ladder -type cable rack systems shall consist of 3 inch minimum side channels with suitable cross channels (rungs) installed on 6 inch centers unless otherwise indicated. Straight sections, fittings, etc., for ventilated-type cable rack systems, shall have 3 inch minimum high sides and a ventilated bottom with cross pieces 2 inches (maximum) wide on 3 inch (maximum) centers and openings 2 inches (maximum) wide. Cable rack widths shall be as shown on the drawings.

4.6.4 Raceway support systems

4.6.4.1 General

Raceways shall be securely supported at intervals specified in the NEC Article 300-11, "Securing and Supporting", and fastened in place with pipe straps, wall brackets, hangers, or ceiling trapezes. Fastenings shall be by wood screws, nails or screw -type nails to wood; by toggle bolts on hollow masonry units; by expansion-bolts on concrete or brick; by machine screws, welded threaded studs, or spring tension clamps on steel work. Nail type nylon anchors or threaded studs driven by a power charge and provided with lock washers and nuts may be used in lieu of expansion bolts, machine screws, or wood screws. Threaded C clamps with retainers may be used. Raceways or pipe straps depth of more than 1-1/2 inch in reinforced concrete beams, or to a depth of more than 3/4 inch in reinforced concrete joists, shall not cut the main reinforcing bars. Holes not used shall be filled. In partitions of light steel construction, sheet-metal screws may be used. Raceways shall not be supported from sheet -metal roof decks. In suspended-ceiling construction, raceways shall not be fastened to the suspended-ceiling supports.

4.6.4.2 Telephone and signal raceways

Telephone and signal system raceways shall be installed in accordance with the previous requirements for conduit and tubing, with the additional requirements that no length of run shall exceed 50 feet for 1/2-inch and 3/4-inch sizes, and 100 feet for 1-inch or larger sizes; and shall not contain more than two 90-degree bends or the equivalent. Pull or junction boxes shall be installed to comply with these limitations, whether or not indicated on the drawings. Bends in conduit, 1 inch and larger, shall have minimum inside radii of 12 times the nominal conduit diameter.

4.6.5 Conductors

4.6.5.1 Uninsulated conductors

Uninsulated conductors shall be copper and in accordance with Federal Specification QQ-W-343.

4.6.5.2 Insulated conductors

Unless otherwise indicated, insulated conductors shall be copper with thermoplastic or thermosetting insulation, type THW, THWN, and XHHW for general use, or type THHN for use in dry locations only, all insulated for 600 volts in accordance with Federal Specification J-C-30. Unless otherwise indicated, conductors No. 10 AWG and smaller shall be solid. Conductors No. 8 AWG and larger shall be stranded. Minimum branch circuit conductor size shall be No. 12 AWG. Stranded conductors may be used with wire compression connectors or a pressure washer

type lug; lugs with screw only compression are not allowed. Minimum control wire size shall be No. 14 AWG unless noted otherwise. Stranded conductors smaller than 10 AWG is allowed in applications where vibration and flexing may be encountered.

4.6.5.2.1 Fixture wiring

Fixture wiring shall be thermoplastic insulated copper, rated for 600 volts, in accordance with Federal Specification J -C-30 and the NEC.

4.6.5.2.2. Color coding

All feeder and branch circuits, including neutral conductors, shall be identified at both ends of the conductor with panel and circuit number indicated. This shall be accomplished using shrink embossed labels only. The color coding shall be continuous throughout the facility on each phase conductor to its point of utilization so that the conductor phase connection is readily identifiable. Equipment grounding conductors shall be color coded green. Conductors covered with green insulation with yellow, orange, violet or red tracers shall be used for other grounding systems. Neutral conductors shall be white insulated for 120/208/240 volt systems and gray insulated for 277/480 volt systems. For conductors, No. 4 AWG and larger, where appropriate insulation color is not available, color coded tape, half lapped for a minimum length of 3 inches shall be used. Switch leg conductors shall be violet insulated. Green, white, and gray insulated conductors shall not be reidentified. All conductor color codes including reidentified conductors shall be visible at all junction boxes, pullboxes, panelboards, outlets, switches, at access locations in closed raceways, every three (3) feet in open raceways, under all raised floors and at all terminations. Phase conductors shall be color coded as follows:

Single Phase

<u>120 Volts</u>	<u>120/208/240 Volts</u>
Line 1 - Black	Line 1 - Black
	Line 2 - Red
Neutral - White	Neutral - White

Three Phase

<u>120/208/240 Volts</u>	<u>277/480 Volts</u>
Phase A – Black	Phase A - Yellow
Phase B – Red	Phase B - Brown
Phase C – Blue	Phase C - Orange
Neutral - White	Neutral - White/Gray

Color coding for conductors in control cables shall be in accordance with NEMA Standard WC 5. DC power conductors. shall be color coded as follows: positive conductor, red with brown tracer; negative conductor, brown with red tracer; neutral conductors, if used, shall be white.

4.6.5.3 Splices

Splices shall be made only at outlets, junction boxes or accessible raceways. Splicing of ungrounded conductors in panelboards is not permitted. Splices shall be made with solderless connectors conforming to UL 486A, UL 486C, AND UL 486E. Insulated wire nuts may only be used to splice conductors sized No. 10 AWG and smaller. Compression connectors shall be used to splice conductors No. 8 AWG and larger. All splices, including those made with insulated wire nuts, shall be insulated with electrical tape or shrink tubing to a level equal to that of the factory insulated conductors. All underground splicing shall be accomplished in accordance with FAA -C-1391.

NOTE:

Conductors in critical power systems shall not be spliced.

4.7 Boxes

Boxes shall be either the cast –metal threaded-hub type conforming to UL 514A and UL514B, galvanized steel type conforming to UL 514A and UL 514B, or metal outlet boxes conforming to NEMA OS 1. All enclosures shall conform to NEMA standards.

4.7.1 Applications

Boxes shall be provided in the wiring or raceway system for pulling wires, making connections, and mounting devices or fixtures. All outdoor boxes shall be rated minimum NEMA 3R. In hazardous areas, boxes shall be explosion proof. Each electrical outlet box shall have a machine screw which fits into a tapped hole in the box for the ground connection. Boxes shall be sized in accordance with the NEC Article 370. Boxes for mounting lighting fixtures shall not be less than 4 inches square. Boxes installed for concealed wiring shall be provided with extension rings or plaster covers. The front edge of the box shall be flush or recessed not more than 1/4-inch from the finished wall surface. Boxes for use in masonry –block or tile walls shall be square-cornered tile-type, or standard boxes having square-cornered tile-type covers. Cast-metal boxes installed in wet locations and boxes installed flush with exterior surfaces shall be gasketed. Separate boxes shall be provided for flush or recessed fixtures where required by the fixture terminal operating temperature, and fixtures shall be readily removable for access to the boxes unless ceiling access panels are provided. Boxes for fixtures on suspended ceilings shall be supported independently of the ceiling supports. Boxes shall not be supported from sheet -metal roof decks. Non-metallic boxes may be used only with non –metallic raceway systems.

4.7.2 Supports

Boxes and supports shall be securely fastened to wood with wood screws, nails, screw -type nails, carriage bolts, or lag screws of equal holding strength, with bolts and expansion shields on concrete or brick, with toggle bolts on hollow masonry units, and with machine screws or welded studs on steel work. Support systems shall be capable of carrying the weight of the box and its contents. Threaded studs driven by powder charge and provided with lock washers and nuts, or nail -type nylon anchors may be used in lieu of expansion shields, or machine screws. In open overhead spaces, cast -metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast -metal boxes having threadless connectors and sheet-metal boxes shall be supported directly from the building structure or by bar hangers. Where bar

hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24 inches from the box. Penetration shall be no more than 1-1/2 inches into reinforced concrete beams nor more than 3/4-inch into reinforced concrete joists. Main reinforcing steel shall not be cut.

4.8 Wiring devices

4.8.1 Receptacles

All receptacles shall be specification grade in accordance with NEMA STD WD -1. Unless otherwise indicated, general purpose duplex receptacles shall be specification grade, 20 ampere rating, 125 volt, grounding type NEMA 5-20R. Receptacles with push -in connections or a combination of screw-type and push-in connectors are not acceptable. Unless noted otherwise, receptacles shall be installed 12 inches above finished floor. All receptacles, unless they are of the isolated -ground type, shall be grounded by the installation of a green grounding pigtail from the receptacle grounding screw directly to the grounding screw on the outlet box where the green equipment grounding conductor is terminated. NOTE: For all critical power circuits, the receptacles shall be twist lock type except where the receptacles are not subject to be kicked or bumped (e.g., receptacles mounted inside an equipment rack).

4.8.1.1 General.

4.8.1.2 Ground fault circuit-interrupter (GFCI) receptacles

GFCI receptacles shall be installed in all locations required by the NEC and in other locations as indicated on the drawings. GFCI receptacles shall be 125-volt, duplex, UL Group I, Class A, rated for 20 amperes minimum. All exterior GFCI receptacles shall be mounted in weatherproof boxes with weatherproof covers.

4.8.1.3 Reserved

4.8.1.4. Isolated ground terminal receptacles

When isolated ground terminal receptacles are shown in the contract documents, they shall be installed in accordance with Article 250-74 exception #4, of the NEC. Isolated ground terminal receptacles shall only be used where shown on the drawings. All isolated ground terminal receptacles shall be colored orange.

4.8.1.5 Plug-in strip outlets

4.8.1.5.1 General

Fixed multi-outlet assemblies shall consist of a surface metal raceway with grounding type receptacles. Phase and neutral conductors shall not be smaller than No. 12 AWG and shall have the type of insulation specified for branch circuit conductors. In addition, a No. 12 AWG or larger green insulated equipment grounding conductor having the same insulation as the phase conductors shall be installed. This grounding conductor shall connect all receptacle ground terminals and each section of the surface metal raceway, and shall be securely connected to the equipment grounding conductor from the branch power panel. Where more than one circuit is

indicated as serving a group of similar receptacles in a common raceway, adjacent receptacles shall not be connected to the same circuit.

4.8.1.5.2 Associated hardware

Surface metal raceways shall be provided with snap-on blank covers and/or snap-on receptacle covers for the receptacles furnished, all manufactured by the raceway manufacturer. They shall be installed to prevent open cracks. Where industry standard device plates are to be installed on raceways, snap-on blank covers shall be accurately cut to avoid open cracks. Fittings, elbows, clips, mounting straps, connection blocks, and insulators, shall be provided as required for a complete installation.

4.8.1.6 Emergency light receptacles

Emergency light receptacles shall be grounding type single receptacles in accordance with NEMA standard WD 1.

4.8.2 Wall switches

Single-pole and three-way wall switches shall be specification grade, rated 120/277 volts, and shall be fully rated 20 amperes, AC only. Wiring terminals shall be of the screw type. Switches with push-in connections or a combination of screw-type and push-in connections are not acceptable. Switches shall be equipped with grounding terminals and shall be grounded with a green grounding pigtail connected from the switch grounding screw directly to the grounding lug or screw on the outlet box where the green equipment grounding conductor is terminated. Switches shall be the quiet-operating type. Not more than one switch shall be installed in a single gang position.

4.8.3 Device plates

Plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plate screws shall be of metal with countersunk heads, in a color to match the finish of the plate.

Telephone and communication outlets shall be provided with a blank cover plate unless otherwise indicated. Plates shall be installed with all four edges in continuous contact with finished wall surfaces with the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch. The use of sectional type device plates will not be permitted. Plates installed in wet locations shall be gasketed. Device plates for telephone and intercommunication outlets shall have a 3/8-inch bushed opening in the center or a dome-shaped grommet on the side.

4.8.4 Photoelectric control

Unless otherwise indicated, photoelectric controls for floodlighting or obstruction lighting shall be 120 volt, 3000 watt, single-pole, single-throw, double-break type. Photoelectric controls shall be mounted in an appropriate weatherproof housings installed on the building exterior. The housing should be vented if possible, faced in a northerly direction. At no time shall the controllers be mounted in the same enclosure with the batteries.

4.9 Service equipment

4.9.1 Power

Service entrance equipment and installation for power shall be in accordance with the regulations of the local utility providing service and NEC Article 230.

4.9.1.1 Service entrance conduits

Service entrance conduits shall be installed as shown on the drawings and shall be heavywall zinc coated rigid steel unless otherwise indicated. Grounding bushings shall be installed on both ends of the service entrance conduit.

4.9.1.1.1 Underground service

Underground service entrance conduits shall be installed a minimum of 2 feet below finished grade. Service entrance conduit shall be electrically continuous between the service disconnecting means and the facility transformer housing. The conduit shall be bonded to the counterpoise.

4.9.1.1.2 Aerial service

A minimum of 4 feet of slack in all service entrance conductors shall be extended from an appropriate weatherproof entrance fitting to permit connection to the service drop. Conduit shall be concealed within the building where possible and conduit penetrations into the building shall be caulked with sealing compound.

4.9.1.2 Service disconnecting means

Service equipment shall be a fused disconnect switch, separately mounted circuit breaker, or main circuit breaker in the main distribution panel. All switches and circuit breakers used as service entrance disconnecting means shall be UL rated for service equipment.

4.10 Panelboards

4.10.1 General

Panelboards shall be dead-front type, shall conform to Federal Specification W -P-115, Type I, Class I, and shall be listed by UL except for installations which require special panelboards to incorporate items not available as UL listed. Panelboards shall be mounted so that the height to the top of the panelboard shall not exceed 81 inches above the finished floor level. Unless otherwise specified, panelboards shall have a full hinged front cover with a hinged door in that cover for access to circuit breaker switches. Doors shall have flush type cylinder locks and catches. Doors over 48 inches in height shall have auxiliary fasteners on top and bottom. All locks in a project shall be keyed alike, and two keys shall be furnished with each lock. Directories shall be type written to indicate the load served by each circuit and shall be mounted on the inside of the door in a holder with a protective covering. Circuits shall be connected as indicated on the drawing. The directory shall be arranged so that the typed entries simulate circuit breaker positions in the panelboard.

4.10.2 Wiring gutters

The minimum size of side wiring gutters shall be 4 inches for power feeders up to and including 100 amperes, 6 inches for power feeders over 100 amperes and up to 225 amperes, and 8 inches for power feeders over 225 amperes and up to 600 amperes.

4.10.3 Circuit breakers

Circuit breaker ratings shall be in accordance with the SCA/PDC study, FAA Order 6950.27. All circuit breakers shall be UL listed thermal magnetic type or electronic solid state type, as described herein, and with a minimum rating of 10,000 AIC. Circuit breakers shall also have trip ratings, voltage ratings, and number of poles as defined on the drawings. All circuit breakers shall have a trip indicating feature. Single -pole breakers shall be full-size modules. Two-pole and three-pole breakers shall be physically sized in even multiples of a single-pole breaker. Breakers shall be sized so that two single-pole breakers can not fit in a single housing. Multipole circuit breakers shall have an internal common trip mechanism. All circuit breakers and the panelboards in which the breakers are installed shall be products of the same manufacturer. Plug in type load centers and/or plug in type branch or feeder circuit breakers shall not be used. Positive integral locking plug-in circuit breakers, and associated panelboards, may be used.

4.10.3.1 Thermal magnetic

All thermal magnetic breakers shall be quick make, quick break type conforming to Federal specification W-C-375. Adjustable breakers shall have setting adjustments readily accessible and visible from the front of the panel board, after installation.

4.10.3.2 Solid state

Adjustable, solid-state or microprocessor-controlled circuit breakers shall have adjustments readily accessible and visible from the front of the panelboard, after installation. Individual circuit breaker frame size shall not exceed the panelboard bus rating.

4.10.3.3 Self enclosed circuit breakers

4.10.3.3.1 General

Circuit breakers shall be UL listed thermal magnetic type or electronic solid state type, as described herein. Multiple circuit breakers shall have an internal common trip mechanism. Circuit breakers shall comply with Federal Specification W -C-375.

4.10.3.3.2 Thermal magnetic

These circuit breakers shall be of the molded-case type, shall have a quick -make and quick-break toggle mechanism, inverse -time trip characteristics and shall be trip -free on overload or short-circuit. Automatic release shall be secured by a BI-metallic thermal element releasing the mechanism latch. In addition, a magnetic armature shall be provided to trip the breaker instantaneously for short -circuit currents above the overload range. Automatic tripping shall be indicated by a handle position between the manual OFF and ON positions.

4.10.3.3.3 Solid state/microprocessor

These circuit breakers may be used providing they meet or exceed the performance characteristics given by paragraph 4.10.3.3.2 above.

4.10.4 Bus bars

All phase bus bars shall be copper or plated copper. Neutral and ground bus bars shall be copper or plated copper. Bus capacity shall be as indicated on the drawings. Where bus capacity is not indicated on the drawings, the capacity shall be equal to or greater than the panelboard feeder overcurrent protective device. Except as indicated paragraph 4.10.3, circuit breaker current-carrying connections shall be bolted. Bus bar connections to branch circuit breakers shall be of the sequence phase type. The neutral bus shall be insulated from all panelboards except where the panelboard is used as the service disconnecting means. Where "provisions for," "future," or "space" is noted on the drawings, the panelboard shall be equipped with bus connections for the future installation of circuit breakers.

4.10.4.1 Ground bus

All panelboards shall have an uninsulated ground bus that is separate from the neutral bus. The ground bus shall be securely bonded to the cabinet and adequately sized for the panelboard capacity and with the number of terminations equal to the number of poles in the panelboard. The ground bus shall only be bonded to the neutral bus at the service disconnecting means. The ground bus bar shall be structurally integral to the panelboard or attached to the panelboard with a bolt, nut and lock washer. If the ground bus bar is mounted to the enclosures with screw threads only (i.e., tapped blind hole) a separate, bolted ground lug shall be installed on the panelboard and bonded to the ground bus bar. The bond conductor shall have the same current carrying capacity as the largest equipment grounding conductor terminated to the ground bus bar.

4.11 Reserved.

4.12 Safety switches

Safety switches shall be type "HD," heavy duty, locking type unless otherwise indicated. Switches mounted in dry locations shall be NEMA type 1 enclosures. Switches installed outdoors, or in damp locations shall be mounted in NEMA type 3R enclosures. Switches shall be of the voltage and current ratings indicated on the drawings. Switches shall be the quick-make, quick-break type. Except for ground lugs which shall be bonded to the housing, all parts shall be mounted on insulating bases to permit replacement of any part from the front of the switch. All current -carrying parts shall be of high-conductivity copper unless otherwise specified. Switch contacts shall be silver -tungsten or plated to minimize corrosion, pitting and oxidation. When used for motors a safety switch shall be sized in accordance with NEC Article 380. Switches shall disconnect all ungrounded conductors.

4.13 Cabinets

Telephone and signal systems cabinets shall be constructed of zinc coated sheet steel in accordance with NEC Article 373-10, and shall meet the requirements of UL 50. Cabinets shall be constructed with interior dimensions not less than those indicated on the drawings. Cabinets shall be mounted so that the height to the top of the cabinet does not exceed 81 inches above the finished floor level. A locking catch and two keys shall be provided with each cabinet unless

otherwise indicated. All locks in a project shall be keyed alike. Cabinets shall also be provided with a 5/8-inch plywood backboard unless otherwise indicated.

4.14 Motors and controls

4.14.1 Motors

Motors furnished under this specification shall be of sufficient size for the duty to be performed, and shall not exceed the full-load rating when the driven equipment is operating at specified capacity. Motors shall be rated for the voltage of the system to which they are to be connected. Unless otherwise indicated, all motors shall have open frames, and continuous -duty classifications. Polyphase motors shall conform to NEMA Standard MG-1, and shall be type II, class 3, minimum insulation class B, squirrel-cage type, having normal starting -torque and low-starting-current characteristics, unless otherwise specified. When motor horsepower ratings are indicated on electrical drawings, these ratings are only approximate. Higher ratings may be required to adequately power driven equipment selected by the contractor for the duty to be performed.

4.14.2 Motor controls

Each motor, 1/8 horsepower or larger, shall have overload protection in each phase, or other equally rated method in accordance with the NEC. The overload-protection device shall be provided either integral with the motor, or with the control, or shall be mounted in a separate enclosure. In any case the reset button shall be in an accessible location. Unless otherwise indicated, the protective device shall be of the manual reset type. Single or double-pole tumbler switches specifically designed for AC operation may be used as manual controllers for single – phase motors having a current rating not in excess of 80 percent of the switch rating. Automatic control devices such as thermostats and float or pressure switches may control the starting and stopping of motors directly, provided the devices used are designed for that purpose and have an adequate horsepower rating. When the automatic control device operates the motor directly, a double -throw, three-position tumbler or rotary switch shall be provided for manual control.

4.14.2.1 Reduced-voltage controllers

Reduced voltage starting methods when required shall be as indicated on the drawings.

4.14.3 Motor disconnecting means

Each motor shall be provided with a disconnecting means and a manually operated switch as shown on the drawings or when required by the NEC. For single-phase motors, a single-pole or double-pole toggle switch, rated only for AC, will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor full load amperages (FLA). Enclosed safety switches shall conform with paragraph 4.12 above.

4.15 Dry-type transformers

4.15.1 General

Dry-type transformers shall be of the sizes and characteristics shown on drawings. Unless otherwise indicated, the design, manufacture, and testing of dry-type transformers, and the

methods of conducting tests and preparing reports shall be in accordance with NEMA ST 20, and UL standards. These transformers shall be dry-type self-cooled (Class AA) as defined by ANSI/IEEE C57.12.80. Unless otherwise indicated, minimum Basic Insulation Levels (BIL) shall be in accordance with IEEE STD 141.

4.15.2 Windings and taps

Dry-type transformers shall be provided with separate primary and separate secondary windings for each phase. The transformers shall be provided with copper windings. Unless otherwise indicated, each primary winding of each transformer rated 15 KVA and greater shall be provided with four taps, two of which shall provide 2-1/2 percent increments above full rated voltage and two of which shall provide 2-1/2 percent increments below full rated voltage. Each primary winding of each transformer rated below 15 KVA shall, be provided with not less than two taps, each providing a 5 percent increment above and below full rated voltage.

4.15.3 Insulation

Insulation provided in transformers having ratings not exceeding 25 KVA shall have 185°C rise rating. Insulation provided in transformers having ratings exceeding 25 KVA shall have 220°C rise rating.

4.15.4 Terminal compartments

Each dry-type transformer shall be provided with a suitable terminal compartment to accommodate the required primary and secondary wiring connections, and side or bottom conduit entrance.

Transformers having ratings not exceeding 25 KVA shall be provided with terminal leads equipped with factory installed and supported connectors. Transformers rated greater than 25 KVA shall have terminal boards equipped with factory installed clamp-type connectors. The terminal compartment temperature shall not exceed 75°C when the transformer is operating continuously at rated load with an ambient temperature of 40°C.

4.15.5 Sound pressure levels and vibration isolation

Sound pressure levels of dry-type transformers shall be determined in accordance with NEMA Standard ST 20. Levels shall not exceed 40 db for transformers rated at 9 KVA or less; 45 db for transformers rated over 9 KVA but not over 50 KVA; and 50 db for transformers rated over 50 KVA but not over 150 KVA. All dry-type transformers 45 KVA and greater shall have integral vibration isolation supports between the core and coil assembly and the transformer enclosure. Transformers of lesser rating shall have either integral or external vibration isolation supports. Conduit connections to transformers shall be made with flexible metal conduit, nominally 12 inches length but not more than 36 inches in length.

4.15.6 Enclosures

Single-phase transformers larger than 25 KVA and three-phase transformers larger than 15 KVA shall be fully encased in steel enclosures. Transformers smaller than 15 KVA shall be fully encased in steel enclosures with or without compound fill, or shall have exposed cores, impregnated windings, and steel enclosures encircling all live parts. Enclosures shall be bonded

to the grounding system. The surface temperature of the transformer shall not exceed 65°C when the transformer is operating continuously at rated load with an ambient temperature of 40°C.

4.15.7 Mounting

Transformers shall be mounted to allow for adequate ventilation. Unless otherwise indicated on drawings, dry-type transformers having ratings not exceeding 25 KVA shall be suitable for wall mounting. Shop drawings of wall brackets and platforms for transformers shall be submitted for approval.

4.16 Identification

Motor controllers, panelboards, safety switches and self-enclosed circuit breakers shall be identified with a name plate showing the functional name of the unit, voltage utilized, the number of phases, and other pertinent formation. Switches for local lighting need not be identified. Additional equipment shall be identified if called for on the drawings.

4.16.1 Name plates

Name plates shall be non-ferrous metal or rigid plastic, stamped, embossed or engraved with 3/8-inch minimum height characters. The plates shall be secured to the equipment with a weather - proof bonding material or a minimum of two screws.

4.17 Fuses

A complete set of fuses shall be installed and one set of spares shall be furnished for each fusible device. Time and current tripping characteristics of fuses serving motors or connected in series with circuit breakers shall be determined by the facility Protective Device Coordination Study (PDC). Fuses shall have a voltage rating not less than the circuit voltage. Required fuse interrupting ratings, determined by the Short Circuit Analysis (SCA) calculations, shall be as shown on the drawings, except that these interrupting ratings shall not be less than 100,000 amperes in branch and feeder circuits, and not less than 200,000 amperes in a service entrance switch.

4.18 Lamps and lighting fixtures

4.18.1 General

Lamps and lighting fixtures shall be of the types indicated on the drawings. All lighting fixtures shall be UL approved and shall bear the UL label. All incandescent lamps shall be rated for 130 volts unless otherwise indicated. Flexible metal conduit, minimum 3/8 inch nominal trade size is permitted. External bonding jumpers are not required across the lighting fixture flexible conduit.

4.18.2 Fluorescent fixtures

Unless otherwise indicated, fluorescent fixture lenses shall be the prismatic -type, made of virgin acrylic. Fluorescent lamps shall be rapid start, cool white unless otherwise indicated. Ballasts for fluorescent fixtures shall be class P, protected (including inherent automatic thermal reset and fuse) rapid start, high power factor type, conforming to UL Standard UL 935. Unless otherwise indicated, all ballasts shall be provided with factory installed choke-type radio frequency

interference suppressers. Lampholders shall have silver plated contacts, and shall conform to standard UL 542.

4.18.2.1 Recessed fluorescent fixtures

Recessed fluorescent fixtures shall conform to NEC Article 410-64 through 410-72, and shall be installed in suspended ceiling openings. These fixtures shall have adjustable fittings to permit alignment with ceiling panels.

4.18.2.2 Suspended fluorescent fixtures

Pendant-mount fluorescent fixtures shall conform to Federal Specification W-F-414 and shall be of the types indicated on the drawings. Single-unit suspended fluorescent fixtures shall have twin-stem hangers. Multiple-unit or continuous row fluorescent units shall have tubing or a stem for wiring at one point, and tubing or a stem suspension provided for each unit length of chassis, including one at each end.

4.18.3 Suspended incandescent fixtures

Pendant-mounted incandescent fixtures shall be provided with swivel hangers to insure a plumb installation.

4.18.4 Emergency lights

Emergency lights shall conform to Federal Specification W-L-305, type I, class I, style D or E, with the number of heads as indicated on the drawings. Emergency light sets shall be connected to the wiring system by a cord no more than 3 feet in length to a single receptacle.

4.18.5. High intensity discharge (HID) lamps

HID lamps including mercury vapor, metal halide, and high or low pressure sodium shall be as indicated on the drawings. High power factor, constant wattage ballasts shall be furnished with HID lamps. Mercury vapor lamps shall be the color improved type.

4.19 Signal and communications

4.19.1 Entrance conduits

Conduit materials shall be RSC unless otherwise indicated. Except where otherwise indicated, underground conduits shall be a minimum of 2 feet below finished grade and extend at least 5 feet beyond the grounding electrode system. The conduits shall be bonded to the grounding electrode system with No. 2 AWG bare copper conductor by exothermic welds or FAA - approved pressure connectors. Conduits installed for future use by others, such as for telephone, communications, electronic signals, etc., shall have both ends capped.

4.19.2 Transient protection demarcation box for electronic landlines

A metallic, appropriately rated NEMA junction box, shall be installed where electronic landlines or conduits enter the facility. This box will house terminal boards, cables, and circuit transient protectors as shown on the contract drawings.

4.19.3 Fiber optics

The use of fiber optics is recommended to replace metallic, control cables. Using fiber optics will eliminate outages and loss of service due to lightning strikes.

4.20 Painting and finishing

Where factory finishes are not adequate to protect metal surfaces from corrosion, the contractor shall paint exposed surfaces prior to or after installation. All marred or damaged surfaces, except exposed metal for grounding purposes, shall be refinished to leave a smooth, uniform finish at final inspection.

4.21 Repair of existing work

Electrical work shall be carefully planned. Where cutting, channeling, chasing, or drilling of floors, wall partitions, ceilings, or other surfaces is necessary for the proper installation, support, or anchorage of the conduit, raceways, or other electrical work, it shall be carefully done. The contractor shall repair, with equal material by skilled workers, any damage to facilities caused by the contractor's workers or equipment. Contracting Officer's prior approval must be obtained for the materials, workers, time of day or night, repair method, and for temporary or permanent repairs purposes. On completion, repair work shall be inspected and approved by the Contracting Officer with the concurrence of any other affected parties such as utility companies and airport authorities.

5. QUALITY ASSURANCE PROVISIONS

5.1 List of materials and equipment

When required by the contract the contractor shall submit a list of materials and equipment to the Contracting Officer for approval.

5.1.1 Information required

This list shall include manufacturer's style or catalog numbers. Partial lists submitted from time to time shall not be considered as fulfilling this requirement. Approval of materials will be based on manufacturer's published data. Approval of materials and equipment will be tentative, subject to submission of complete shop drawings, when required, indicating compliance with the contract documents.

5.1.2 Statement

A manufacturer's statement indicating complete compliance with the applicable federal specification, military specification, or standards of ASTM, NEMA, or other commercial standard, is acceptable as indicating compliance with contract documents.

5.2 Shop drawings

When required by the contract or by direction of the contracting officer, the contractor shall submit shop drawings for materials and equipment not completely identified by information submitted in the materials and equipment lists. This information shall include, but is not limited to panelboards, lighting fixtures, cable trays, switchgear, transformers, busways, cabinets, and

lightning protection systems. In addition, the contractor shall provide the completed Short Circuit Analysis/Protective Device (SCA/PDC) study, FAA Order 6950.27.

5.2.1 Coordination

Drawings and submitted data shall be checked and coordinated with the work of other construction trades involved, before they are submitted for approval, and shall bear the contractor's stamp of approval as evidence of such checking and coordination.

5.2.2 Required data

Drawings and submitted data shall be complete, assembled in sets and shall bear the date, drawing revision number, name of project or facility, name of contractor and subcontractor, and the clear identity of contents and location of work.

5.2.3 Approval

The approval of drawings and submitted data shall not be construed as (1) permitting any departure from the contract requirements; (2) relieving the contractor of the responsibility for any errors, including details, dimensions, materials, etc.; or (3) approving departures from full size details furnished by the Contracting Officer.

5.2.4 Variations

If drawings show variations from the contract requirements because of standard shop practice or for other reasons, the contractor shall describe such variations in a letter of transmittal to the Contracting Officer. If acceptable, the Contracting Officer may approve any or all such variations, subject to a proper adjustment in the contract. Contractors failing to describe such variations shall not be relieved of the responsibility for executing the work in accordance with the contract, even though such drawings have been approved.

5.2.5 Submission

The contractor shall submit and obtain approval of shop drawings by the Contracting Officer before ordering materials or proceeding with any work associated with the shop drawings.

5.3 Tests

5.3.1 General

Unless otherwise indicated, the contractor shall furnish all test instruments, materials and labor necessary to perform the following tests. All tests shall be performed in the presence of the Contracting Officer or his designated representative. All instruments shall have been calibrated within a period of two years preceding testing. Calibrations shall be traceable to applicable industry recognized standards.

5.3.2 Cables

All cables shall be tested in accordance with FAA Order 6950.22 prior to installation and again upon completion of the installation. All testing shall be accomplished before connection is made to any existing equipment.

5.3.3 Load balancing

After the electrical installation has been completed, the contractor shall take current readings with a true RMS ammeter for the purpose of load balancing. These readings shall be taken at the service entrance, each feeder panelboard, each branch panelboard, and each separately derived source. The contractor shall redistribute single-phase loads where there is greater than a 20% difference between readings in any two phases. The contractor shall also be required to notify the Contracting Officer of current readings taken before and after installation, and any phase loaded above 80% of the rating of its overcurrent protective device.

5.3.4 Insulation resistance tests

Feeder and branch circuit insulation tests shall be performed after installation, but before connection to fixtures or appliances. Motors shall be tested for grounds or short circuits after installation but before start -up. All conductors shall test free from short circuits and grounds, and have a minimum phase-to-phase and phase-to-ground insulation resistance of 30 megohms when measured with a 500-volt DC insulation resistance tester. Apply the test voltage for at least one minute after the meter reading has stabilized. The contractor shall submit a letter type test report to the Contracting Officer prior to final FAA inspection of the contractor's work. The report shall list the tests performed and results obtained.

5.3.5 Neutral isolation tests

For all new installations, the neutral in the service entrance switch shall be tested for isolation from ground with an ohmmeter capable of reading greater than 20,000 ohms. This procedure to be used is detailed in the Appendix. This procedures can also be used to determine if there are any other neutral –ground connections on the load side of the service disconnecting means.

5.3.6 Earth resistance test

To demonstrate compliance with paragraph 4.4.4, the contractor shall measure the resistance of the grounding electrode system. Tests shall not be conducted within 48 hours of a rainfall or in frozen soil. The contractor shall immediately notify the Contracting Officer if the specified resistance is not obtained. Upon project completion, the contractor shall also submit a written test report to the Contracting Officer, defining the test procedure and results obtained.

5.3.7 Operating test

After the interior wiring system installation is completed, and at such time as the Contracting Offer may direct, the contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of this specification. The test shall be performed in the presence of the Contracting Officer or designated representative.

6. NOTES

6.1 General

This specification is to be used as part of the contract documentation for construction and facility modification projects that do not require major design efforts. No waivers to contractors, other than those indicated as alternatives, are allowed. This specification is not to be used as a design guide. For design information, consult FAA-STD-019, Lightning Protection, Grounding,

Bonding and Shielding Requirements for Facilities; FAA-STD-020, Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment; FAA Order 6950.19, Practices and Procedures for Lightning Protection, Grounding, Bonding, and Shielding Implementation; FAA Order 6950.20, Fundamental Considerations for Lightning Protection, Grounding, Bonding and Shielding and other documentation as applicable.

6.2 Conflicts between documents

In all but the smallest of modification or construction contracts, conflicts are unavoidable between the various documents cited in the contract or referenced in an included specification. Any proposal request using this document should contain the following provisions: "Prospective contractors shall, as part of their proposals, enumerate, identify, and list conflicts that exist with the contract documents, and between those documents and the rules, regulations, and codes of the local utility company and local, county or state governing bodies."

Appendix

FACILITY NEUTRAL/GROUND ISOLATION TESTING

The following testing is to be utilized to verify required isolation between facility neutral and ground systems within the electrical distribution system and facility equipment. Neutral grounding at the service entrance disconnect means is still required by NFPA, NEC Article 250.

EQUIPMENT NEEDED: Volt-ohm meter, flash light, allen wrenches, screw drivers, socket wrenches, and wire markers.

NOTE 1: A resistance value of greater than 20,000 ohms is the minimum value for an acceptable neutral/ground isolation test. Any lesser value indicates an unacceptable isolation condition that must be investigated.

NOTE 2: Capacitors on the neutral line or capacitive effects of the distribution system will impact resistance readings. Always use the final, stabilized readings.

NOTE 3: High impedance meters are susceptible to acting as an antenna, picking up stray fields that would not be picked up by lower impedance meters. For this series of tests, it is highly recommended that low impedance meters be used, such as an analog meter the Simpson 260 or its equivalent, or use a digital meter the Fluke 8060a series or its equivalent.

STEPS:

1. Schedule a facility outage in order to conduct the tests.
2. Review one-line diagrams of the facility electrical distribution system.
3. Isolate and lock out all standby power sources.
4. Remove facility power by opening the service disconnect means.

CAUTION: Voltage is still present at the supply side (line side) of the service entrance disconnect.

5. Verify that no voltage is present at the load side of the service disconnect means with the voltmeter using progressively lower scales.
6. Open all circuit breakers in the facility distribution system.
7. Disconnect load side neutral conductor(s).

8. Measure resistance between disconnected load side neutral conductor(s) and the service entrance enclosure ground bus.
9. If resistance reading is acceptable, reconnect neutral conductor(s) and terminate testing.
10. If resistance reading is unacceptable, tag the grounded neutral conductor(s) and leave the conductor(s) disconnected.
11. Trace the tagged conductor(s) to the load and correct the unacceptable neutral/ground bond, or to the next downstream (towards the load) neutral termination.
12. At the next downstream location, remove each load side neutral conductor one at a time and measure resistance between the conductor and the enclosure. If the resistance reading is acceptable, re-terminate the conductor. If the resistance reading is unacceptable, tag the grounded neutral conductor and leave it disconnected. Measure resistance of the rest of the neutral bus immediately after identifying a grounded conductor, to possibly verify the rest of the bus as acceptable.
13. Continue downstream as described above until all unintentional neutral/ground bonds are found and corrected.
14. Reconnect all neutral conductor(s) except at the service entrance disconnect means. Measure resistance between the load side neutral conductor(s) and the service entrance enclosure to verify successful isolation of neutral/ground conductors.
15. Reconnect neutral conductor(s), close service entrance disconnect means.
16. Place standby power source on line.